Before the
Federal Communications Commission
Washington, D.C. 20554

In the Matter of	)	
	)	
Amendment of the Commission's Part 90 Rules	)	WT Docket No. 06-49
In the 904-909.75 and 919.75-928 MHz Bands	)	

COMMENTS

OF

PROGENY LMS, LLC

May 30, 2006

SUMMARY

Progeny LMS, LLC ("Progeny") welcomes the Commission's re-examination of the rules that govern Multilateration-Location and Monitoring Service (M-LMS) licensees in the 904-909.75 MHz and 919.75-928 MHz spectrum bands. The Commission's Notice of Proposed Rulemaking (NPRM) provides a singular opportunity to implement forward-looking spectrum policies in these bands that will serve the public interest in multiple ways: promoting valuable new homeland security and public safety services, establishing a balance between licensed and unlicensed uses, and providing incentives for all users of the band to adopt the most spectrum-efficient technologies. The Commission should take the opportunity to reach these public interest benefits by replacing outmoded and non-functioning service restrictions and burdensome regulations with a service-neutral regulatory framework in this band that allows all users – licensed and unlicensed – the freedom to develop and offer advanced, market-driven services.

Progeny currently is developing an Enhanced Position Location (EPL) service that will provide valuable enhancements for the public safety and homeland security markets. Granting service flexibility, moreover, also will allow M-LMS licensees to address a market for network services that can complement, support and cross-fertilize many of the latest technologies for unlicensed devices. Elimination of the service restrictions that now restrain

M-LMS licensees is in the public interest, because it will allow the full effectiveness of the 902-928 MHz band to be realized, reaffirming the Commission's judgment more than a decade ago that coexistence of licensed commercial services and unlicensed uses in the band is not only possible but beneficial.

Rule Changes Will Reflect New Market, Regulatory Realities

The NPRM opens an important chapter for M-LMS services, reflecting the new realities of the wireless market for location-based services, which now include widespread GPS capabilities and Enhanced 911 functions on cell phones. The effect of the current service restrictions in the Part 90 rules to preclude the deployment of *any* M-LMS services in the band is well-known. These unnecessary restrictions, based on a command-and-control regulatory regime the Commission has long abandoned, have stymied development of M-LMS services and have failed to provide incentives for existing Part 15 devices to employ more advanced, efficient technologies. In the meantime, important opportunities for cross-fertilization of technologies in this band have been lost.

To allow all users in this band to maximize spectrum use, efficiently and effectively, the Commission must eliminate outmoded service restrictions by: (1) removing restrictions on the type and content of messages that can be carried by M-LMS systems, permitting licensees to go beyond transmission of status and instructional messages related to location-only functions; (2) discarding the rule that allows M-LMS licensees to provide non-vehicular location services only if an LMS system's "primary operations" involve provision of vehicle location services; and (3) lifting all restrictions on real-time interconnection with the public switched telephone network.

Similarly, the Commission should eliminate other M-LMS rules that have been superseded by technological developments and changing market conditions and do not contribute to interference mitigation. To this end, the Commission should remove the spectrum aggregation restriction for M-LMS licensees, which has outlived its original purpose of preserving competition in the band. Permitting spectrum aggregation would facilitate the reduction of interference of M-LMS systems to Part 15 devices by allowing interference avoidance techniques to operate over a larger bandwidth. The unnecessary and burdensome M-LMS field-testing condition also should be eliminated, reflecting the fact that compliance is not practical given the lack of engineering standards for testing.

M-LMS Operations Pose No Significant Interference Risk

Progeny intends to use state-of-the-art radio equipment, taking advantage of technological advancements in power control, interference avoidance, spread spectrum techniques, mesh networking architectures and smart antennas. Progeny previously has demonstrated to the Commission that an LMS system operating at 30 Watts ERP (effective radiated power) would cause no more interference to Part 15 devices than would other Part 15 devices. Since submitting this assessment to the Commission four years ago, advancements in radio equipment point to a level of interference risk that is further diminished or even non-existent.

Moreover, reducing the allowed output power from 30 Watts ERP to 6.1 Watts ERP would not reduce the risk of harmful interference. M-LMS systems would be compelled to make up for this lower allowed output power by building more transmitters to cover the same geographic area. Thus, the lower output power would not reduce the potential interference risk to Part 15 devices and would increase network build-out and operational costs to a level that would continue to foreclose the deployment of viable systems in M-LMS spectrum. In Progeny's view, the Commission should allow M-LMS systems using closed loop power control systems and sectorized antennas to operate above the 30 Watt ERP limit, commensurate with the interference-reduction level facilitated by these technologies and in line with rules for other spectrum bands.

Progeny's proposals to eliminate unnecessary service restrictions and other outdated rules will (1) preserve full spectrum access for the multiple types of spectrum users that co-exist in this band, (2) provide incentives for efficient use by both M-LMS and Part 15 operations, (3) foster the deployment of technologically advanced services in this band, and (4) minimize any potential for M-LMS operations to cause harmful interference to other users. Progeny believes that service flexibility, coupled with proactive interference-mitigation techniques, will be the catalyst for growth of all services in this band, as it has been in others. It commends the Commission for issuing the NPRM and strongly urges it to follow through by replacing the current command-and-control service restrictions, spectrum cap and testing requirements with a flexible regulatory regime that leverages spectrum-efficient technologies to promote a broad array of innovative services in the 902-928 MHz band, in coexistence with other licensees and Part 15 devices.

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COMMENTS OF PROGENY LMS, LLC

Progeny LMS, LLC ("Progeny") hereby submits its comments to the Federal Communications Commission ("the FCC" or "the Commission") on the proposals contained in the Commission's Notice of Proposed Rulemaking in Wireless Telecommunications Docket No. 06-49, released on March 7, 2006 ("the NPRM.").[1] In the NPRM, the Commission initiated a comprehensive re-examination of its Part 90 Rules as they pertain to the 904-909.75 MHz and 919.75-928 MHz bands.[2] Progeny lauds the Commission for moving forward with its NPRM in this proceeding. Progeny strongly urges the Commission to follow through with proposals to eliminate the service restrictions that have

[1] *Amendment of the Commission's Part 90 Rules in the 904-909.75 and 919.75-928 MHz bands*, Notice of Proposed Rulemaking, WT Docket 06-49, Rel. March 7, 2006 (*NPRM*).

[2] Since 1995, these bands have been licensed to several entities, including Progeny, for Multilateration Location and Monitoring Service ("M-LMS"). Progeny is the largest holder of spectrum in the M-LMS band, with 8 MHz of bandwidth in Economic Areas ("EAs") covering a population of 235 million. In addition, these bands have also been the home of federal uses, Amateur Service and a variety of unlicensed uses under Part 15 of the Commission's Rules.

prevented M-LMS (Multilateration-Location and Monitoring Service) licensees from realizing the full potential of this spectrum band.[3] Establishing a flexible approach here – as the Commission has in other bands – is in the public interest, as it will give licensees the ability to deploy the most effective and efficient technologies, and cross-fertilize those technologies with those of other users in the band. Progeny believes this approach will foster the most productive and best use of the 902-928 MHz band.

The lifting of service restrictions and other outdated regulations will pave the way for Progeny and other M-LMS licensees to pioneer advanced, location-based services that the market demands, particularly to meet vital homeland security and public safety needs. Moreover, flexibility will give licensees freedom to develop systems that support and dovetail with the growing use of unlicensed, Part 15 devices in the band. Meanwhile, as Progeny will show in this filing, the use of current, state-of-the-art spectrum technologies will allow M-LMS licensees to operate with less potential for harmful interference than Part 15 devices today may cause to other Part 15 devices. In short, with this NPRM, the Commission has opened up a new era of productive coexistence, growth in innovative homeland security and public safety services, technological innovation and spectral efficiency in the 902-928 MHz band.

[3] For purposes of this filing, Progeny uses the term "M-LMS" to refer to a full range of potential advanced wireless services in the 902-928 MHz band, including – but not limited to – location-based services and applications.

I. Current Service Restrictions Are Outdated, Ineffective and Should Be Modified or Eliminated

When the Commission enacted the Part 90 M-LMS rules, it sought to promote the development of LMS in a way that would harmonize with other users of the 902-928 MHz band. The Commission mandated provision of "location only" service, restricting the types and content of messages that could be sent and requiring vehicle location and tracking to be the primary offering. It also limited the ability of licensees to interconnect on a real-time basis with the public switched telephone network (PSTN).[4] For reasons that the Commission could not have foreseen when it adopted those rules more than a decade ago, these restrictions no longer serve the public interest. They have combined with marketplace realities to stymie any development of M-LMS services in the band, despite the band's highly favorable propagation characteristics. As long as these restrictions remain – increasingly at odds with the Commission's policy of service flexibility and neutrality in other bands – licensees will be unable to utilize the 902-928 MHz bands for the advanced LMS services the Commission intended.

For that reason, Progeny respectfully requests that the Commission eliminate the current service restrictions by enacting changes to its Part 90 Rules that will:

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[4] *See* 47 C.F.R § 90.353, ¶¶ (b), (c), (g) (2006).

- Eliminate all restrictions on the type and content of messages that can be carried by M-LMS systems, allowing licensees to go beyond transmission of “status and instructional messages” related to location and monitoring functions (47 C.F.R. §90.351 and §90.353(b));
- Eliminate the rule allowing M-LMS licensees to provide non-vehicular location services *only* if their LMS systems’ “primary operations involve the provision of vehicle location services” (47 C.F.R. §90.353(g)); and
- Eliminate all restrictions on real-time interconnection with the public switched network (47 C.F.R §90.353(c)).

In place of these service restrictions, Progeny asks the Commission to establish a service-neutral regime in the 902-928 MHz band, giving licensees flexibility to provide any and all services prompted by current and emerging market demand and conditions. Progeny believes that technical parameters, applied to both licensed and unlicensed operations, will be more effective than the current service rules in fostering the coexistence of multiple, cross-fertilizing technologies in the band. The NPRM notes the opportunity presented by the FCC here “to consider the spectrum access needs of multiple users and to evaluate any proposals that may improve access and use of the band by both M-LMS and Part 15 operations."[5] Progeny believes that the approach outlined herein addresses both of these important factors.

A. Market Changes Have Rendered Location-Only Tracking Service Obsolete in the M-LMS Bands.

When it set the service restrictions on M-LMS operations in 1995,[6] the Commission could not have contemplated the marketplace and regulatory developments that would alter the market for location-based services. What previously had been a niche market for "automatic vehicle monitoring" services – intended as a pillar of the "intelligent vehicle highway system" was changed in 1995 to the current M-LMS. But this nascent service was rapidly overwhelmed by widespread commercial availability of both satellite-based and terrestrial positioning technologies, in the form of the Global Positioning System (GPS) and the Enhanced 911 (E911) functionality imposed on Commercial Mobile Radio Service (CMRS) providers.

The rapid growth and market adoption of GPS and cellular network-assisted GPS, along with the commensurate widespread availability of location capable mobile devices, had two important impacts: (1) the market for location-based services broadened to include multiple types of commercial

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[5] *See* NPRM at ¶ 4.

[6] *See* Amendment of Part 90 of the Commission's Rules to Adopt Regulations for Automatic Vehicle Monitoring Systems, *Report and Order*, 10 FCC Rcd 4695 (1995) (*LMS Report and Order*).

offerings that were widely available, and (2) positioning capabilities could be offered not as stand-alone tracking services, but rather integrated with communications and information services. These realities are apparent with both GPS – which is widely offered in combination with data-transmission and information services – and E911, which is embedded in the ubiquitous mobile phone handsets and networks that have redefined modern telecommunications.

It should not be forgotten, moreover, that both GPS and E911 technologies were supported and (in the case of E911) *mandated*, by the government itself. In 1996, only a year after the LMS rules were put into place, the Clinton administration announced a policy decision to designate the GPS system as a dual use technology, a decision that led to the improvement of signals available for civilian uses. Over the course of the next decade, GPS capabilities, which had originally been developed by the U.S. government primarily for military uses, became a mainstay of many commercial wireless offerings. The government continues to operate the 24-satellite system in the interests of both military and commercial users.

The consumer impact of this widespread availability of GPS has been dramatic. For example, QUALCOMM's "gpsOne" position location technology, which it describes as the most "widely deployed GPS technology in the world," is available on more than 150 million wireless handsets served by more than 45 mobile operators worldwide.[7] GPS-based in-vehicle location systems have seen a similar level of growth in recent years.[8] Similarly, wireless E911 has been developed largely through the Commission's effort to extend enhanced 911 service into the mobile environment. The development of cellular location technology thus also overtook the stand-alone tracking service that M-LMS licensees were (and still are) required to offer.

As a result, there is no public interest benefit that flows from continuing to limit M-LMS service to promote vehicle and other location-based services in the nation's transportation infrastructure. It is not marketable to offer a terrestrial location-only service in direct competition with GPS, and it is even more pointless to offer a location-only tracking service divorced from information-service or communications capabilities. Forbidding the transmission of information along with positioning data runs contrary not only to market realities, but also to the principle of highest, best use of spectrum resources.

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[7] QUALCOMM, *QUALCOMM Enables Widespread Deployment of Location Services for WCDMA (UMTS) Markets*, Press Release (February 9, 2006) <http://www.qualcomm.com/press/releases/press_list_2006.html>.

[8] OnStar, for example, reported that its customer base in GM vehicles grew by 30 percent to 4 million in 2005, which it attributed to "increased usage and strong acceptance." *See* OnStar, *2005 Marks Watershed Year for ONSTAR*, Press Release (December 26, 2005) <http://onstar.internetpressroom.com/releases.php>.

A similarly unnecessary and overly restrictive limit that does not serve the public interest is the M-LMS prohibition against real-time interconnection with the PSTN (with the exception of emergency communications sent to or received from a system dispatch point or public safety answering points). As the NPRM points out, the original rationale behind this restriction was that it would "ensure that LMS systems are utilized primarily for location service and not as a general messaging or interconnected voice or data service."[9] This reasoning has been undercut by the fact that through such unnecessarily prohibitive restrictions, services in the band have not simply been limited to location-only offerings. Rather, the restrictions have hampered the viability of deploying *any* services in the band. This ban on interconnection no longer reflects marketplace realities or modern technologies, particularly inasmuch as Internet technology can be used for LMS messaging. Indeed, the Commission could not have foreseen the widespread availability of IP networks to deliver real-time messaging as IP-based transmissions when it formulated LMS rules in 1995. Furthermore, this outmoded restriction in no way advances interference protection in the band. As Progeny demonstrates at length in these comments, flexibility in the service rules based on technological capabilities is far more effective than command-and-control regulations at protecting other users of this spectrum from harmful interference.

[9] *LMS Report and Order*, 10 FCC Rcd at 4708 ¶ 23.

The current M-LMS service restrictions, therefore, condemn licensees to a market that does not exist – and is defined so narrowly that it cannot be viable economically. As a result, multiple M-LMS licensees, including Progeny, have documented to the Commission their failed attempts to interest any manufacturers in developing network equipment for M-LMS services.[10]

B. Regulatory Flexibility Will Allow New Services and Technologies To Flourish

Proof that the Commission's proposals in this proceeding are on the right track can be found in recent efforts by Progeny to develop a technical and business case for a system called "Enhanced Position Location" (EPL). This planned system will use technology, for which a patent application has been filed, to locate devices in areas where GPS service does not function adequately. Examples include providing service deep inside buildings or in subterranean areas, and at remote disaster scenes. This service is intended for public safety users and other providers of critical infrastructure, as well as by a broad range of customers in crisis situations. Progeny envisions that EPL technology will be embedded into mobile radios used by public safety

[10] The Commission has acknowledged the lack of available M-LMS equipment based on its own authorization records. *See* In the Matter of Request of Warren C. Havens for Waiver of the Five-Year Construction Requirement for his Multilateration Location and Monitoring Service Economic Area Licenses, *Memorandum Opinion and Order*, 19 FCC Rcd 23742, 23744-23745 ¶ 7 (WTB MD 2004).

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officials, and could, in fact, be embedded into ordinary wireless devices. EPL will deliver significant improvements over current location systems, serving areas where location data and related information are urgently needed but currently unavailable on a broadband basis. Moreover, this service is aligned with the original scope and intentions of the Commission in this band. Full service flexibility is needed and warranted to allow this and other, similar homeland security and public safety services to develop and reach their full market potential. Moreover, granting such flexibility will directly serve the public interest.

In addition, if the service restrictions are eliminated, licensees will be able to leverage the propagation characteristics of the 902-928 MHz band to provide a rich variety of services responsive to market needs, and to cross-fertilize promising new technologies existing within the 902-928 MHz band and within other bands. This is fully in line with the FCC's stated goal in this proceeding "to consider whether greater opportunity can be afforded M-LMS licensees to provide services while ensuring continued access for other licensed and unlicensed uses that share this band."[11] Freed from service restrictions, LMS licensees can develop networks that not only coexist with Part 15 devices, but also support them. As the Commission has noted in its *Wireless Broadband Access Task Force Report,* not only has free spectrum access helped to

[11] *NPRM* at ¶ 4.

accelerate expansion of unlicensed wireless services, but "continually increasing regulatory flexibility has enabled sustained growth as well."[12]

As an example of the types of new services that could flourish in the presence of greater regulatory flexibility, Progeny is investigating the potential of developing a nationwide "overlay network" that would facilitate sharing between licensed operations and existing Part 15 devices in the band. Many Part 15 devices are stand-alone "point solutions" or campus-area communications networks. An advanced overlay network would allow these unlicensed systems to communicate with one another. To facilitate and promote the use of its spectrum for networking and interoperability among unlicensed devices, Progeny's overlay network would employ open interfaces and standardized communication protocols, including TCP/IP. This type of mutually beneficial service development could have immediate, positive impacts on many of the public safety and commercial services desiring to share the 902-928 MHz band today.

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[12] *See* FEDERAL COMMUNICATIONS COMMISSION, WIRELESS BROADBAND ACCESS TASK FORCE REPORT 56 (2006) (*WBATF*). The Report goes on to note: "The Commission rules addressing unlicensed devices do not specify the types of technologies required to be used. Rather, they establish basic technical and operational parameters, allowing manufacturers and service providers to develop and use equipment that is appropriate for a particular application. Furthermore, technological developments, including advanced antenna technologies and more robust modulation techniques, have also contributed to the growth of this market segment." *WBATF* at 57.

In addition, service flexibility also is in the public interest because it will provide positive incentives for all users – licensed and unlicensed – to employ the most technologically advanced, spectrally efficient equipment and techniques. As Progeny will describe in this filing, it is entirely possible for all licensees and unlicensed users to coexist and flourish within this band – and in keeping with the current regulatory hierarchy.[13] All users of this highly valuable band should expect, however, to employ the most efficient technology to cope with spectrum constraints. This includes manufacturers of unlicensed devices under Part 15. The current service restrictions on M-LMS licensees provide no incentives for Part 15 manufacturers and users to deploy the most current, spectrally efficient technologies. Rather, there is a perverse incentive to rely on the continued imposition of antiquated service restrictions to artificially preserve spectrum "open space" for legacy technologies that employ large swathes of spectrum.

[13] The 902-928 MHz band is allocated as follows: (1) federal radiolocation systems and ISM equipment may provide service on a primary basis. (2) federal fixed and mobile services are allocated on a secondary basis to federal radiolocation systems and Industrial, Scientific and Medical (ISM) equipment. (3) LMS licensees are allocated on a secondary basis to federal users and ISM devices and may not cause interference to and must tolerate interference from these users and devices. (4) amateur radio operations may operate on a secondary basis to LMS. (5) unlicensed devices are authorized under Part 15, but they are not afforded interference protection rights and may not cause harmful interference to LMS licensees, amateur operations, or other licensees.

This inverted incentive mechanism risks heightening the potential for harmful interference, including to the Part 15 community itself.[14] The current imbalance in incentives plays out in economic terms. It requires licensees – who have already paid millions of dollars to secure their spectrum – to risk greater investments to acquire and deploy spectrally robust and efficient equipment to operate without engendering harmful interference. Manufacturers of Part 15 devices, however, have no incentive to incur such costs, because they remain under the umbrella of regulatory protection, no matter how inefficiently they may choose to operate. The Commission should promote a fair sharing of the burden for interference mitigation, while at the same time loosening restrictions on the kinds of services licensees can offer, thus enabling licensees to find a market for their services, using the most effective technologies available.

As it stands now, the M-LMS band is a case study of what goes wrong in the absence of flexibility changes that would otherwise ease unnecessary

[14] In January 2006, the American Radio Relay League (ARRL), which represents Amateur Service licensees in the 902-928 MHz band, asked the Commission to reject a request by Octatron, Inc. and Chang Industries, Inc., for a waiver of the Part 15 rules. ARRL opposed the Part 15 providers' plan to employ a 1-watt power level – but using analog rather than digital spread-spectrum technology. ARRL argued that this approach would violate the power spectral density requirement in Section 15.247(e), without meeting the specifications in Section 15.249 for high-power, point-to-point operation using highly directional antennas. *See* ARRL, *In the Matter of OCTATRON, INC. AND CHANG INDUSTRY INC., Request for Waiver of Sections 15.245(b), 15.247(e) and 15.249(a) of the Commission's Rules for a Video and Audio Surveillance System*, Comment, ET Docket 05-356, Rel. January 30, 2006.

and uneconomical restrictions, provide protection from harmful interference, and promote new applications. Without regulatory parity for M-LMS spectrum, the Commission will miss an opportunity to create incentives for efficient operations in the band, based on up-to-date technology. The NPRM has made clear that the Commission does not intend to alter the hierarchy among licensed and unlicensed users in the 902-928 MHz band. Progeny agrees with this conclusion. Progeny's position supports the Commission's desire to preserve the regulatory hierarchy in this band. The Commission has emphasized that it wants to maintain the existing accessibility of this band for unlicensed users, but it can best do so by re-calibrating the service rules in a way that motivates unlicensed users to increase the efficiency of their operations going forward.

C. The Commission Has a Well-Established Policy of Providing Service Flexibility

The Commission's spectrum policies have evolved since 1995, making spectrum flexibility an established Commission policy today. The practice of narrowly prescribing the services a licensee can offer and narrowly detailing the licensee's operations has gradually been eliminated. The Commission made clear the need for, and benefits of, flexibility in its *Policy Statement* for spectrum management, in which it stated, "Flexible allocations may result in more efficient spectrum markets. Flexibility can be permitted through the use of relaxed service rules, which would allow licensees greater freedom in determining the specific services to be offered."[15] Moreover, service flexibility is consistent with the requirements of Section 303(y) of the Communications Act.[16]

In some cases, the Commission has provided flexibility up-front in making new service allocations. For example, with regard to the Personal Communications Service (PCS), the Commission allowed licensees to "provide any mobile communications service on their assigned spectrum. Fixed services may be provided on a co-primary basis with mobile operations."[17] Likewise, for the General Wireless Communications Service (GWCS), licensees are permitted to "provide any fixed or mobile communications service on their assigned spectrum."[18] Similarly, the Commission has provided substantial flexibility for the Miscellaneous Wireless

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[15] *See* Principles for the Reallocation of Spectrum to Encourage the Development of Telecommunications Technologies for the New Millennium, *Policy Statement*, 14 FCC Rcd 19868, 19870-19871 ¶ 9 (1999).

[16] 47 U.S.C. § 303(y) (2006). This provision authorizes the FCC to provide flexibility for spectrum use if it is consistent with international agreements to which the United States is a party and if the FCC finds, after notice and opportunity for comment, that: (A) such an allocation would be in the public interest; (B) such use would not deter investment in communications services and systems, or technology development; and (C) such use would not result in harmful interference among users.

[17] 47 C.F.R. § 24.3 (2006). The only limitation on permissible offerings is that PCS licensees may not provide broadcasting service.

[18] 47 C.F.R. § 26.3 (2006). There are some limitations. GWCS licensees may not provide broadcasting services, radiolocation services or satellite services in these bands.

Communications Services (WCS) licensees.[19] In its recent allocation of frequencies transferred from government to commercial users for Advanced Wireless Service applications, the Commission also provided significant flexibility.[20]

In other cases, the Commission has revised older rules to provide greater flexibility for existing licensees when market changes required it. In 2003, the Commission allowed Mobile Satellite Service (MSS) licensees in the L-band, 2 GHz and "Big LEO" bands to integrate an "ancillary terrestrial component" (ATC) into their MSS systems. [21] The Commission recognized that providing service flexibility would increase the efficiency of spectrum use, reduce costs, eliminate inefficiencies, enhance operational ability, strengthen market competition and provide additional communications that may enhance public protection.[22]

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[19] 47 C.F.R. § 27.2 (2006).

[20] *Reallocation of the 216-220 MHz, 1390-1395 MHz, 1427-1429 MHz, 1429-1432 MHz, 1432-1435 MHz, 1670-1675 MHz and 2385-2390 MHz Government Transfer Bands*, Report and Order, 17 FCC Rcd 368 (2002).

[21] *See* Flexibility for Delivery of Communications by Mobile Satellite Service Providers in the 2 GHz Band, the L-Band, and the 1.6/2.4 GHz Bands; Review of the Spectrum Sharing Plan Among Non-Geostationary Satellite Orbit Mobile Satellite Service Systems in the 1.6/2.4 GHz Bands, *Report and Order and Notice of Proposed Rulemaking*, 18 FCC Rcd 1962, 1964 ¶ 1 (2003) (*MSS Flexibility R&O*).

[22] *Id.* at 1965 ¶ 1.

The Commission also revised the rules for the Interactive Video and Data Service ("IVDS") to provide substantially more flexibility. The original service envisioned for IVDS – interactive television applications – proved to be commercially nonviable, and licensees found that they were hampered by service rules narrowly tailored to such a service (a circumstance which has recurred with respect to M-LMS). Through a series of actions, the Commission waived or suspended certain build-out, auction payment, and technical rules.[23] In 1999, the Commission then re-named the service the "218-219 MHz Service" and substantially revised the service rules in order to allow licensees flexibility to provide additional fixed and mobile services in response to market demand.[24] Incremental service flexibility was added to the band, but the changes lagged behind market conditions, preventing a real-time response to changing demand. In the 1999 *Order* granting

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[23] *Interactive Video and Data Service (IVDS) Licenses Request for Stay*, Order, 12 FCC Rcd 13129 (1996) (FCC Order allowing certain IVDS auction winners to pay on an installment plan basis). *Amendment of Part 95 of the Commission's Rules to Allow Interactive Video and Data Service Licensees to Provide Mobile Service to Subscribers,* Report and Order, 11 FCC Rcd 6610 (1996) (FCC Order allowing IVDS licensees to offer mobile service while removing certain technical limitations). *Amendment of Part 95 of the Commission's Rules to Modify Construction Requirements for Interactive Video and Data Service (IVDS) Licenses,* Report and Order, 11 FCC Rcd 2472 (1996) (FCC Order waiving a one-year construction "build-out" requirement for IVDS Licensees).

[24] *Amendment of Part 95 of the Commission's Rules to Provide Regulatory Flexibility in the 218-219 MHz Service*, Report And Order And Memorandum Opinion And Order, 15 FCC Rcd 1497, 1499 ¶ 1 (1999) (*218-219 MHz Order).*

additional flexibility, the FCC acknowledged that deployment of the 218-219 MHz service had not yet been successful, as the "the vast majority of licensees have yet to provide service."[25]

This impasse was reached despite earlier, incremental steps to promote the development of services in the band, including piecemeal relief regarding certain construction requirements and authorization of mobile as well as fixed operation in this spectrum. Five years later, the Commission noted that development of services in this spectrum was still lagging. The Wireless Telecommunications Bureau stated in the 2004 *Biennial Regulatory Review* that "the 218-219 MHz Service could soon provide sources of competition for other wireless services. However, competition is developing slowly, due in part to…the limited permissible use of the service before its restructuring."[26] In part, the changes to the 218-219 MHz rules illustrate what happens when the Commission attempts to use command-and-control spectrum management to keep up with changing market conditions. Nevertheless, they reveal the FCC's willingness to respond with rule changes to enable licensees to adapt to ongoing market shifts.

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[25] *Id.* at 1505 ¶ 13. The *218-219 MHz Order* noted that few licensees have been able to offer service in this band. "Moreover, those licensees actually deploying services are providing service different than that originally envisioned when the service was established." *Id.* at 1506 ¶ 13.

[26] FEDERAL COMMUNICATIONS COMMISSION WIRELESS TELECOMMUNICATIONS BUREAU, 2004 BIENNIAL REGULATORY REVIEW 120, Staff Report, WT Docket No. 04-180 (2005).

Meanwhile, the Commission also substantially expanded the flexibility afforded to licensees for the Multipoint Distribution Service ("MDS"). The Commission combined MDS and Multichannel Multipoint Distribution Service ("MMDS") to create the Broadband Radio Service (BRS) in 2004.[27] Traditionally, MDS spectrum had been used to deliver multi-channel video programming services similar to cable television. In March 1996, the Commission completed its auction of the remaining unlicensed MDS spectrum with the expectation that it would be used for the provision of "wireless cable" services. Almost immediately, the Commission began taking steps to clear a path for licensees to find a market. In July 1996, the Commission's *Digital Declaratory Ruling* permitted licensees to utilize digital modulation techniques on their MDS spectrum.[28] In October 1996, the

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[27] *See* In the Matter of Amendment of Parts 1, 21, 73, 74 and 101 of the Commission's Rules to Facilitate the Provision of Fixed and Mobile Broadband Access, Educational and Other Advanced Services in the 2150-2162 and 2500-2690 MHz Bands, Part 1 of the Commission's Rules - Further Competitive Bidding Procedures Amendment of Parts 21 and 74 to Enable Multipoint Distribution Service and the Instructional Television Fixed Service, Amendment of Parts 21 and 74 to Engage in Fixed Two-way Transmissions, Amendment of Parts 21 and 74 of the Commission's Rules With Regard to Licensing in the Multipoint Distribution Service and in the Instructional Television Fixed Service for the Gulf of Mexico, Promoting Efficient Use of Spectrum Through Elimination of Barriers to the Development of Secondary Markets, *Report and Order and Further Notice of Proposed Rulemaking*, 19 FCC Rcd 14165 ¶ 16 (2004).

[28] *See* In the Matter of Request for Declaratory Ruling on the Use of Digital Modulation by Multipoint Distribution Service and Instructional Television Fixed Service Stations, *Declaratory Ruling and Order,* 11 FCC Rcd 18839, 18840 ¶ 1 (1996).

Commission allowed MDS operators to use their spectrum for high-speed digital data applications, including Internet access.[29]

Subsequently, in March 1997 the Commission received petitions from individual licensees and an MDS trade association seeking a change in the rules to allow licensees to provide two-way services, including high-speed broadband service. In 1998, the Commission allowed MDS and Instructional Television Fixed Service (ITFS) licensees (which shared the 2500-2690 MHz band) to carry interactive transmissions.[30] The Commission also granted MDS and ITFS licensees an even more service-neutral allocation by adding a mobile allocation to the band. The Commission's objective was to help develop that band for 3G advanced wireless services.[31] The continued actions taken in what is now the BRS/ERS proceeding[32] represent the Commission's

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[29] *See* The Mass Media Bureau Implements Policy for Provision of Internet Service on MDS and Leased ITFS Frequencies, *Public Notice,* 11 FCC Rcd 22419 (1996).

[30] *See* In the Matter of Amendment of Parts 21 and 74 to Enable Multipoint Distribution Service and Instructional Television Fixed Service Licensees to Engage in Fixed Two-Way Transmissions, 13 FCC Rcd 19112, 19113 (1998) *(Two-Way Order)*, *recon.*, 14 FCC Rcd 12764 (1999), *further recon.*, 15 FCC Rcd 14566 (2000).

[31] *See* Amendment of Part 2 of the Commission's Rules to Allocate Spectrum Below 3 GHz for Mobile and Fixed Services to Support the Introduction of New Advanced Wireless Services, Including Third Generation Wireless Systems, *First Report and Order and Memorandum Opinion and Order*, 16 FCC Rcd 17222, 17223 ¶ 2 (2001).

[32] More recently the Commission issued an order to facilitate the further development of wireless broadband services. *In the Matter of Amendment of Parts 1, 21, 73, 74 and 101 of the Commission's Rules to Facilitate the*

willingness and commitment to continue granting additional flexibility so that existing licensees may maximize the use of their spectrum in a rapidly evolving wireless service marketplace.

As these examples indicate, the Commission has established through an extensive public record, in multiple proceedings, that granting existing or new licensees flexibility to offer market-driven services is justified, particularly when changes in the market and regulatory environment have altered the "ground truth" that pertained when the original service rules were fashioned. The M-LMS bands provide yet another example of where such flexibility is not only justified but essential to realize the Commission's overall policy goals of promoting the highest, best usage of spectrum and providing incentives for more efficient spectrum use throughout the band.

Provision of Fixed and Mobile Broadband Access, Educational and Other Advanced Services in the 2150-2162 and 2500-2690 MHz Bands; Part 1 of the Commission's Rules - Further Competitive Bidding Procedures; Amendment of Parts 21 and 74 to Enable Multipoint Distribution Service and the Instructional Television Fixed Service Amendment of Parts 21 and 74 to Engage in Fixed Two-Way Transmissions; Amendment of Parts 21 and 74 of the Commission's Rules With Regard to Licensing in the Multipoint Distribution Service and in the Instructional Television Fixed Service for the Gulf of Mexico; Promoting Efficient Use of Spectrum Through Elimination of Barriers to the Development of Secondary Markets; Review of the Spectrum Sharing Plan Among Non-Geostationary Satellite Orbit Mobile Satellite Service Systems in the 1.6/2.4 GHz Bands; Amendment of Part 2 of the Commission's Rules to Allocate Spectrum Below 3 GHz for Mobile and Fixed Services to Support the Introduction of New Advanced Wireless Services, Including Third Generation Wireless Systems, Order on Reconsideration and Fifth Memorandum Opinion and Order and Third Memorandum Opinion and Order and Second Report and Order, 2006 FCC LEXIS 2082 (released April 27, 2006) (*Wireless Second R&O*).

II. The Commission Should Maintain the Current Output Power Limits for M-LMS Systems and Introduce Fair Limits on Power Spectral Density

The Commission has requested comment on whether M-LMS systems should be restricted to 6.1 Watts ERP total output power, and regarding defined limits on power spectral density (PSD). Currently, M-LMS systems are allowed to operate at an average output power of 30 Watts ERP (and at 300 Watts ERP in three narrowband channels) with no specified limits on PSD.

While Progeny agrees with the Commission that PSD is an appropriate way to establish technical limits, PSD calculations need to be redone to reflect a correct comparison with Part 15 devices. Progeny is able to demonstrate that an M-LMS system operating at 30 Watts ERP will cause negligible interference to Part 15 devices operating in the 902-928 MHz band (including, notably, automatic meter reading devices). Progeny is further able to demonstrate that reducing the allowed output power for M-LMS systems will have no effect on the geographic area of interference, since the reduction in power will result in a compensating increase in the number of transmitters covering the same geographic area.

Progeny firmly believes that the proposed reduction in output power for M-LMS systems will have no meaningful impact on the interference environment. Meanwhile, it will cause the cost of M-LMS systems to become uneconomical to deploy and operate, will hinder useful inter-operation among licensed and unlicensed users of the band, and, in short, will deny public safety and commercial users the opportunity to reap maximum benefits from this spectrum.

A. Reducing the Allowed Output Power for M-LMS Systems Will Not Improve the Interference Environment for Part 15 Devices

The main goal of reducing the average output power for M-LMS systems is to limit potentially harmful interference to Part 15 devices operating in the band. Progeny has conducted a rigorous engineering analysis based on real-world equipment and conditions, however, and it is able to demonstrate that M-LMS systems operating at 30 Watts ERP provide *negligible interference* to the vast majority of Part 15 devices.

Progeny demonstrated in a white paper (see Appendix A), submitted pursuant to its 2002 rulemaking petition, that an LMS system operating at 30 Watts ERP would cause *less interference to Part 15 devices than other Part 15 devices themselves*. The white paper included a thorough, real-world assessment using actual product specifications to analyze interference scenarios for every major unlicensed system active in the 902-928 MHz band. The white paper assumed that Progeny would deploy standard radio equipment. In the intervening four years since the paper was published, the state of the art of radio equipment has improved dramatically, especially in areas such as power control, interference avoidance, spread spectrum techniques, mesh networking and smart antennas. Progeny intends to deploy radio equipment utilizing capabilities such as these, and in fact its actual level of interference will be even less than the level predicted in the 2002 white paper.

1. At the Current Allowed Output Power Levels, M-LMS Systems Will Not Interfere with the Most Common Part 15 Devices

While the exact number and location of Part 15 devices operating in the 902-928 MHz band is not known, Progeny understands that the vast majority of Part 15 devices comprise indoor communication devices such as cordless telephones and outdoor automatic meter reading (AMR) devices.[33] Progeny is able to demonstrate, using rigorous analysis and real-world parameters, that an M-LMS system operating at the allowed 30 Watts ERP output power level causes negligible interference to these devices, and in no way impedes their normal operation.

First, consider the case of indoor Part 15 devices such as cordless telephones, which have the ability to operate anywhere in the band and could receive co-channel signals from an M-LMS system. Because these devices operate indoors, they are "insulated" (by about 8 dB) from co-channel

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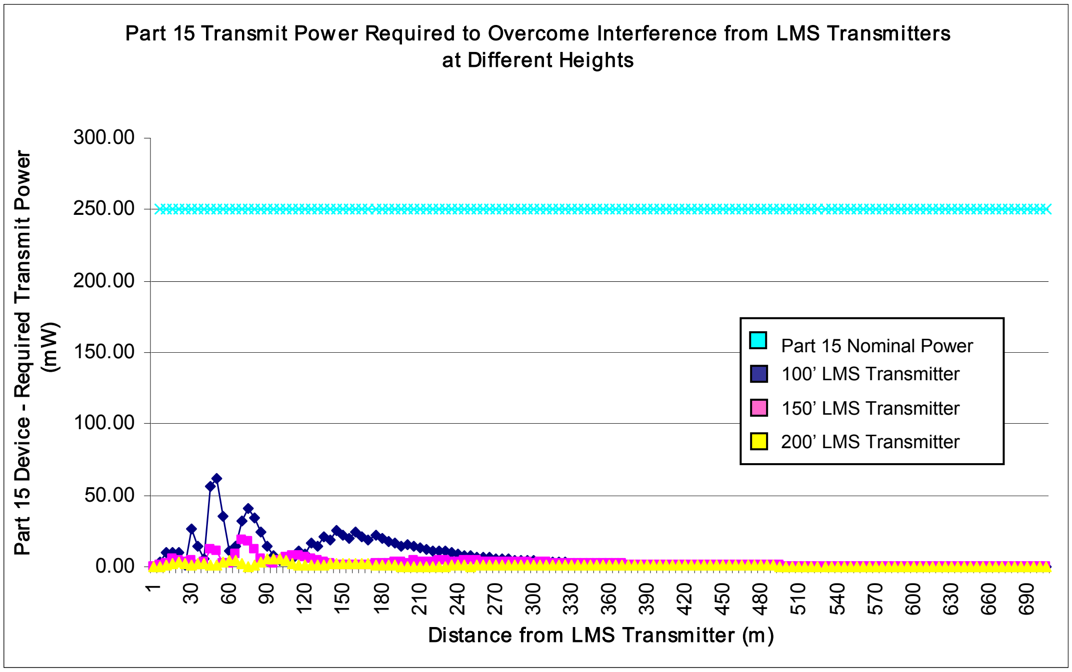
[33] In its June 4, 2003 *Ex Parte* filing with the Commission, Itron indicated it had deployed a total of 23 million AMR devices in the 902-928 MHz band. Itron, *Ex Parte filing on RM-10403* (released June 4, 2003).

interfering signals originating outdoors. These devices are permitted to operate at up to 4 Watts equivalent isotropically radiated power (EIRP) (36 dBm), but in most cases only operate at 250 milliwatts EIRP (24 dBm) or less, which is sufficient for short-range communications within a home. If a Part 15 device of this type encounters interference, it may automatically boost its output power or change its operating channel to improve the carrier-to-interference (C/I) margin.

Progeny analyzed the effect of a 30-Watt ERP M-LMS transmitter at three different heights (100, 150, and 200 feet) and across a range of distances (1 to 700 meters) from an indoor Part 15 device. The objective was to determine the circumstances under which the Part 15 device would be unable to generate sufficient output power to overcome interference from the M-LMS transmitter.

Using the parameters and conditions outlined in the white paper (suburban setting, COST-Walfisch-Ikagami propagation model, Decibel Products Wide Band Panel Antenna DB876G90A-XY), Progeny is able to show that *under no circumstances* does the Part 15 device receive interference requiring it to operate above its nominal 250 milliwatt level. In fact, at no time does the Part 15 device need to operate at greater than 63 milliwatts (18 dBm) in order to maintain communication integrity.



Second, consider the case of Itron's AMR devices, which operate outdoors and transmit data to meter readers or nearby base stations at 915 ±3 MHz.[34] These devices operate well outside the licensed M-LMS band; their center frequency is 6 MHz from the closest edge of the M-LMS "A Block" and 4 MHz from the closest edge of the M-LMS "B Block." It is a standard engineering practice for radio receivers to be able to tolerate signals

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[34] Progeny analyzed the performance characteristics 54 devices submitted by Itron to the FCC for type acceptance testing between 1986 and 2006. Of these, the vast majority operate in the 910-920 MHz range, entirely outside the M-LMS band (with the exception of 25 kHz overlap into the "B Block," which begins at 919.75 MHz). Only six devices were found whose operation partially overlaps with the M-LMS blocks, and all of these are frequency hopping devices designed to withstand interference. The analysis used here is based on published FCC test results for Itron's flagship CENTRON® meter, which transmits at 917.58 MHz. *See* ITRON ELECTRICITY METERING, INC.*,* FCC PART 15.247 TRANSMITTER CERTIFICATION TEST REPORT*,* FCC ID: SK9C1A-2, ACS Report Number: 04-0396-15C-DTS (2005), filed with the FCC's Office of Engineering and Technology.

transmitting up to and beyond -28.8 dBm in *adjacent* channels. Using the parameters and conditions outlined in the white paper (suburban setting, COST-Walfisch-Ikagami propagation model, Decibel Products Wide Band Panel Antenna DB876G90A-XY), Progeny has determined that the M-LMS signal is far below the -28.8 dBm threshold for tolerable adjacent channel signal strength, regardless of the proximity of the M-LMS transmitter to the AMR device.[35]

The two scenarios described in this section – potential M-LMS interference to an indoor cordless telephone and potential M-LMS interference to an AMR device – are particularly important because they represent the impact of M-LMS transmitters on the most common and widely used Part 15 devices. In both scenarios, Progeny is able to demonstrate that operating at the current allowed average output power level of 30 Watts ERP

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[35] It should be noted that, in a series of orders beginning in 2000, the Commission addressed the need for AMR spectrum by upgrading the telemetry operations allocation in the 1429.5-1432 MHz band from secondary to primary. It also allocated the adjacent 1427-1429.5 MHz band for Wireless Medical Telemetry Service (WMTS) on a primary basis and established service rules for medical and non-medical telemetry in the 1427-1432 MHz band. As a result of these actions, Itron informed the Commission in 2004 that it had "developed a new generation of automatic meter reading systems that it is marketing to electric, gas and water utility companies" using that band. *See* Itron, Inc., *In the Matter of Preliminary Views on WRC-Related Issues*, Comment, 2-3, DA-04-1698, Rel. July 2, 2004, *citing* Amendment of Parts 2 and 95 of the Commission's Rules to Create a Wireless Telemetry Service, *Report and Order*, 15 FCC Rcd 11,206 (2000); Amendments to Parts 1,2,27 and 90 of the Commission's Rules To License Services in the 216-220 MHz, 1390-1395 MHz, 1427-1429 MHz, 1429-1432 MHz, 1432-1435 MHz, 1670-1675 MHz and 2385-2390 MHz Government Transfer Bands, *Report and Order*, 17 FCC Rcd 9980 (2002).

causes no harmful interference, and is in fact well below the level of interference that could be caused by other Part 15 devices operating in the vicinity.

2. Reducing the Allowed Output Power from 30 Watts ERP to 6.1 Watts ERP Will Require More M-LMS Transmitters To Cover the Same Geographic Area, Resulting in an Identical Interference Environment for Part 15 Devices in the Area

If the Commission's proposed output power limit of 6.1 Watts ERP is adopted, M-LMS systems will be forced to compensate by adding more transmitters to cover the same geographic area. Ironically, the additional transmitters, although individually operating at lower power levels, will result in exactly the same composite interference in the geographic coverage area as fewer transmitters operating at higher power. This claim holds regardless of the applied propagation model or interference threshold. A mathematical demonstration of this statement is provided in Appendix B.

B. Reducing the Allowed Output Power from 30 Watts ERP to 6.1 Watts ERP Will Make Commercial Services in the M-LMS Band Commercially Infeasible

At the current allowed average output power level of 30 Watts ERP, an M-LMS transmitter operating in an urban area will have a coverage radius slightly less than one-quarter of a mile.[36] Such a coverage radius results in moderate to high tower density, and hence higher capital and operating costs. Reducing the M-LMS power limit to 6.1 Watts ERP would result in an average urban cell radius of *only 800 feet*, escalating the network build-out and operational management costs for M-LMS licensees to a level that is economically disastrous. The end result would be little different than the existing circumstance: overly restrictive rules that foreclose any chance for licensees to attract capital or manufacturing interest to build viable systems.

C. M-LMS Licensees Should Be Allowed Higher Power Limits If They Employ Technology To Mitigate Potential Interference

Progeny submits that M-LMS systems should be allowed to operate above the allowed 30 Watt ERP output power level under special circumstances, using well-documented advanced engineering techniques. In particular, Progeny believes M-LMS licensees should be allowed an additional 5 dB in output power when using closed loop power control systems, and an additional variable allowance based on the use of sectorized antennas.

Power management techniques can be enabled through power control loops between the transmitter and receiver. In such systems, the receiver

[36] Progeny LMS, *LMS Compatibility with Part 15 Devices: The Case for Spectrum Flexibility*, White Paper (October 8, 2002) filed with the FCC under RM No. 10403.

reports a link quality metric to the transmitter. If the error rate is low, indicating a good link, the transmitter lowers its power. If the error rate is high, indicating more power is needed, the transmitter increases its power. Such closed loop power control systems can be designed to keep the error rate at an acceptable level while minimizing interference to other receivers. Such loops have become a standard component of CMRS systems such as CDMA. In one of the seminal works in power control for cellular radio systems, Jens Zander demonstrates that a transmitter employing a closed loop power control architecture can consistently reduce the level of interference experienced by other receivers in the coverage area by about 10 dB.[37]

Because Zander's derivations apply to an ideal power control system and not an actual operational system, and because today's power control systems tend to be distributed as opposed to centralized, radio engineers typically attribute only 5 dB to interference reduction deriving from the use of power control. Using this conservative and widely accepted figure, it would be reasonable and fair for the Commission to allow M-LMS licensees to operate at an additional 5 dB of transmitter output power when using closed loop power control systems, thereby recognizing the 5 dB reduction in interference to Part 15 devices made possible by the use of power control.

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[37] Jens Zander, *Performance of Optimum Transmitter Power Control in Cellular Radio Systems*, 41 IEEE TRANSACTIONS ON VEHICULAR TECHNOLOGY 57, 57-62 (February 1992).

The use of sectorized antennas is another technique for reducing interference of M-LMS systems to Part 15 devices. Sectorized antennas focus the transmitted output power in a particular geographic direction and plane of propagation. By concentrating output power in this manner, sectorized antennas reduce output power, and therefore interference, in other directions. In adopting rules for Broadband Radio Service, the Commission agreed to permit additional transmitter output power above the allowed limit equal to 10*LOG*(360/*beamwidth*) dB.[38] Thus, for example, a sectorized antenna with a 90 degree sectorized beamwidth is allowed an additional 6 dB of transmitter output power.

Progeny believes that M-LMS systems employing closed loop power control systems and sectorized antennas should be allowed to operate above the 30 Watt ERP limit commensurate to the level of interference reduction enabled by these technologies, and consistent with the rules governing other bands.

D. A Power Spectral Density Limit of 24 dBm/3 kHz Is Appropriate for M-LMS Systems

Progeny concurs with the Commission's decision to consider power spectral density (PSD) limits for M-LMS systems as a technically reasonable and appropriate approach. Defined limits on PSD, coupled with limits on

[38] 47 C.F.R § 27.50 (h) (1) (ii) (2006).

allowed output power, result in precise and unambiguous operational restrictions that are far more practical than "testing conditions" to ensure mutually non-interfering operations by licensed and unlicensed users of the band.

The question remains: what is the most appropriate and fair PSD limit for M-LMS systems? Progeny accepts the Commission's methodology for calculating the PSD limit, but respectfully submits that the Commission's calculated level of 12 dBm/3 kHz for transmitted power of 6.1 Watts ERP should instead be calculated at 18 dBm/3 kHz.

In calculating its proposed M-LMS PSD level of 12 dBm/3 kHz, the Commission has added 4 dB to the 8 dBm/3 kHz PSD level allowed a Part 15 device in Section 15.247. The 4 dB difference is derived from the 4 dB greater output power proposed for M-LMS systems (10 Watts EIRP, or 40 dBm) over Part 15 devices (4 Watts EIRP, or 36 dBm). Note, however, that the 4 dB power difference is referenced at the *output* of the antenna, whereas the baseline PSD level of 8 dBm/3 kHz for Part 15 devices is referenced at the *input* to the antenna.[39] A Part 15 device operating with a PSD of 8 dBm/3 kHz at the antenna input would exhibit a PSD of 14 dBm/3 kHz at the antenna output, taking into account the use of a 6 dBi gain antenna, as

[39] "For digitally modulated systems, the power spectral density conducted *from the intentional radiator to the antenna* shall not be greater than 8 dBm in any 3 kHz band during any time interval of continuous transmission." 47 C.F.R. 15.247(e) (2006) (emphasis added).

permitted for Part 15 devices. Thus, insofar as the allowed PSD for M-LMS systems should be 4 dB greater than that allowed for Part 15 devices, Progeny submits that the correct PSD calculation for an M-LMS system operating at 6.1 Watts ERP should be 14 plus 4, or 18 dBm/3 kHz. If the Commission elects to maintain the current 30 Watt ERP power limit, as requested by Progeny, the PSD limit for an M-LMS system should then be 24 dBm/3kHz.

E. The Commission Should Maintain the Current 300 Watt ERP Output Power Limit for the M-LMS Narrowband Channels

The Commission sought comment in the NPRM concerning whether M-LMS licensees should continue to be allowed to transmit at 300 Watts ERP on the 25 kHz "forward link" channels associated with each licensed M-LMS sub-block. Progeny asks the Commission to allow the forward link channels to operate at their currently authorized power levels. Reducing their allowed output power would provide no meaningful reduction in interference, and would eliminate the utility of these channels altogether.

Reducing the allowed power on the forward link channels from 300 Watts ERP will have a *de minimis* affect on the interference environment in the band. The three forward link channels occupy only 75 kHz of the total 26 MHz of spectrum – about 3 percent of the 902-928 MHz band. Furthermore, the forward link channels are isolated at the very upper portion of the band, from 927.25-928.00 MHz. In addition to being a miniscule part of the 902-928 MHz band, the forward link channels are far from being the highest-powered services authorized in the spectral neighborhood. Amateur radio operators operating at 902-928 MHz (the "33 cm" band) are allowed to transmit at 1,500 Watts peak envelope power (PEP), and commercial paging systems at 931 MHz are allowed to transmit at 3,500 Watts ERP on towers up to 1,000 feet in height. The 300 Watt ERP allowed for M-LMS forward links pales in comparison.

III. The Part 90 'Safe Harbor' Should Be Modified To Provide Incentives for All Parties To Use Spectrum Efficiently

The Commission seeks comment on its tentative conclusion to retain the so-called "safe harbor"[40] for unlicensed users of Part 15 devices and licensed amateur operations. Progeny appreciates the intent of the Commission to preserve balance and coexistence of multiple uses within the 902-928 MHz band. Therefore, it understands the Commission's instinct to retain a "safe harbor" provision as a way to protect existing unlicensed users from regulatory obligations that would otherwise require them to take steps to mitigate any harmful interference they may have caused. The Commission should avoid, however, preserving incentives for maintaining outdated, inefficient spectrum usage in this band. Therefore, Progeny asks the Commission to modify the safe harbor so that it applies only to existing Part

[40] *See* 47 C.F.R. § 90.361 (2006).

15 devices that are currently operating in the band. The Commission should not extend that indemnity from regulatory mitigation obligations to future unlicensed uses or technologies in perpetuity.

All manufacturers of unlicensed devices under Part 15 should be put on notice that they will be expected to employ state-of-the-art radio technologies that will minimize the potential for harmful interference. Such technologies and techniques are readily available in the marketplace, and the Commission should provide incentives for manufacturers to employ them. Failing to hold Part 15 uses to the same spectrum efficiency standards in the 902-928 MHz band that they face in other bands would be tantamount to providing a perverse incentive to continue using older, spectrally inefficient technologies that will not lead to the best, most productive usage of the band. It is not in the public interest to turn the 902-928 MHz band into a band for older technologies put out to pasture. Indeed, continuing to sanction older technologies on a prospective basis will contribute to Part 15 devices' potential interference with all licensees and, in fact, other Part 15 devices.

Meanwhile, as Progeny has illustrated in these comments and the attached appendices, it is capable of providing its EPL and other services with less potential for harmful interference than Part 15 devices may cause to each other today. As a matter of fairness and good public policy, then, Progeny submits that, given this evidence of proper stewardship of the spectrum resource, the Commission should at least extend to M-LMS licensees the same exemption from regulatory obligations to mitigate interference that it now preserves for Part 15 devices – which, after all, remain below all licensees in the band hierarchy. This should apply to all licensees in compliance with the Commission's M-LMS rules, as modified in this proceeding.

In economic terms, licensees need a threshold of operational consistency in order to establish viable business plans and generate capital and manufacturing interest. As the Section 90.361 provision is now written, it turns regulatory logic on its head by placing the interference avoidance burden where it does not belong – on the licensee. As Progeny has illustrated, no such obligation is needed for M-LMS licensees, provided they operate at the forefront of technical innovation, as Progeny will. So long as the Commission adopts forward-looking technical rules, coupled with a service flexibility approach, M-LMS licensees can operate below the interference threshold set for Part 15 devices. And gradually, if protection is removed for older, inefficient Part 15 devices going forward, the use of those devices will fade out of the band, replaced by more efficient ones.

IV. The Commission Should Eliminate Outdated Provisions of Its Part 90 Rules Governing Spectrum Aggregation and Field Testing

In addition to the current service restrictions, the Commission's M-LMS rules preserve several anachronistic provisions that limit the ability of M-LMS licensees to provide market-based services. Progeny asks the Commission to eliminate these rule provisions, which are unnecessary to prevent harmful interference and do not provide incentives for efficient spectrum use. During the four years since Progeny first asked the Commission to re-evaluate its rules for the 902-928 MHz band, Progeny has maintained that it can provide valuable services, in the public interest, in coexistence with other uses in the band. Progeny remains doubly convinced that it can do so, while minimizing the potential for harmful interference, if it is no longer hamstrung by burdensome regulations that have stifled innovation and failed to promote efficient spectrum usage. The Commission should act now to remove these unwieldy regulations, which are no longer consistent with modern spectrum management techniques and, in the case of the testing requirement, are practically impossible to comply with.

A. The M-LMS Spectrum Aggregation Limit Serves No Purpose and Should Be Eliminated

The Commission seeks comment on whether the original rationale for restricting aggregation of M-LMS licenses to no more than 8 MHz remains valid in the current telecommunications marketplace.[41] Progeny urges the Commission to eliminate this restriction. Not only has it not served its

[41] NPRM, ¶ 34.

original purpose – to preserve competition in the M-LMS band – it is actually counterproductive in the effort to minimize the potential for harmful interference.

The Commission currently allows licensees to aggregate M-LMS spectrum in Blocks B and C, but not to include the 6 MHz in Block A, within any given Economic Area (EA).[42] The rationale 11 years ago for these restrictions was that they would allow a proliferation of multiple M-LMS services.[43] Subsequent history, of course, has demonstrated that this has not occurred and, as long the current restrictions remain in force, cannot be expected any time in the future. There is, in fact, not a single operating M-LMS provider – a result of the restrictions contained in the Commission's current rules (including the spectrum cap). Meanwhile, there has been enormous growth in the availability of location services from other suppliers, including those employing GPS and E911 technologies. In light of the numerous competitive options for other location-based technologies, it is no longer necessary to restrict the amount of spectrum an M-LMS licensee can accumulate in any given market in order to artificially maintain an M-LMS "duopoly." Rather, given the current nonexistence of any operating service, bolstering the ability of the nascent M-LMS industry to compete by

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[42] 47 C.F.R. § 90.353(d), (f) (2006).

[43] *LMS Report and Order*, 10 FCC Rcd at 4722-23 ¶ 48.

aggregating spectrum may unveil more robust competition in the overall market for location-based services. In addition, reducing the number of M-LMS licensees will pay dividends in reducing the complexity of the network environment in each market. A market with a single service provider can consolidate its network profile, leading to fewer towers and other network equipment and lowering the overall noise floor for potential interference.

Disposal of the M-LMS spectrum aggregation limit would be in line with the Commission's decision to end spectrum aggregation limits in other commercial markets, including the CMRS market.[44] The Commission has used spectrum caps only to prevent creation or entrenchment of monopolies in wireless service markets – a situation that is not present, and is unlikely to occur, in the market for advanced wireless services with location capabilities.[45] The Commission should apply the same case-by-case analysis to the overall market for location-based services that it applied in ending the CMRS spectrum cap, especially since the spectrum cap in this case is applied,

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[44] *In the Matter of 2000 Biennial Regulatory Review Spectrum Aggregation Limits For Commercial Mobile Radio Services*, Report and Order, 16 FCC Rcd 2763, 2764 ¶ 1 (2001) (*CMRS Spectrum Aggregation Order*).

[45] In initially setting the CMRS spectrum cap in 1994, the Commission's stated goal was to "discourage anticompetitive behavior while at the same time maintaining incentives for innovation and efficiency." *Implementation of Sections 3(n) and 332 of the Communications Act, Regulatory Treatment of Mobile Services*, Third Report and Order, 9 FCC Rcd 7988, 8105 ¶ 251, 8100 ¶ 238 (1994) (*CMRS Third Report and Order*).

unevenly, to the one branch of the market (M-LMS) that has been rendered nonfunctional by service restrictions.

Moreover, Progeny believes that allowing spectrum aggregation could also lead to reduced interference of M-LMS systems to Part 15 devices. It would allow interference avoidance techniques to operate over a larger bandwidth – up to 14 MHz of spectrum – significantly reducing the probability of interference with a Part 15 device operating in a single narrowband channel. Progeny believes that the best way to minimize the potential for harmful interference is to use the latest spectrum technologies, reducing PSD by spreading the signal across a larger swath of bandwidth.

B. The M-LMS Field Testing Condition Should Be Eliminated as Unnecessary and Counter-Productive

The Commission solicits comments on whether the interference-testing requirement in Section 90.353(d) of its rules is still necessary.[46] Progeny respectfully submits that the requirement is unnecessary, counter-productive and should be eliminated. Rather, as stated in Section II, above, M-LMS licensees will be able to operate with a negligible potential for harmful interference to Part 15 devices, using the most current spectrum-efficient

[46] NPRM, ¶ 39. *See* 47 C.F.R. § 90.353(d) (2006) ("EA multilateration LMS licenses will be conditioned upon the licensee's ability to demonstrate through actual field tests that their systems do not cause unacceptable levels of interference to 47 CFR part 15 devices").

technologies. This obviates the need for any testing requirement – particularly one imposed solely on M-LMS licensees.

The field-testing requirement is not only unduly burdensome for M-LMS licensees, it is essentially impossible to comply with. In practical terms, M-LMS licensees are barred from any realistic chance of meeting the field-testing obligation by the lack of clearly defined engineering standards for testing.[47] When it enacted the M-LMS rules, the Commission expressed an interest in avoiding unilateral establishment of a uniform testing methodology or standard, given the "varied technologies" in the band. It anticipated that M-LMS licensees and unlicensed users of Part 15 devices would collaborate to establish testing guidelines.[48] In ten years, however, that collaboration has yet to occur, let alone produce any testing standards.

It is not surprising that no such collaboration has occurred, because the current rules provide no requirement or incentive for Part 15 users to come forward and produce their technical requirements for interference mitigation. For their part, M-LMS licensees have no way to identify the

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[47] Progeny LMS, LLC, *In the Matter of Progeny LMS, LLC Amendment of Part 90 of the Commission's Rules Governing the Location and Monitoring Service to Provide Greater Flexibility,* Petition for Rulemaking, 27-28 (March 25, 2002) filed with Federal Communications under RM No. 10403. (*Progeny Petition*)

[48] NPRM, ¶ 39, citing *Amendment of Part 90 of the Commission's Rules to Adopt Regulations for Automatic Vehicle Monitoring Systems*, Order on Reconsideration, 11 FCC Rcd 16905, 16912 ¶ 16 (1996).

parties employing Part 15 devices in any given area, much less the concentration or location of those devices. In the absence of any concrete information upon which to base any field tests, M-LMS licensees are left with a requirement to prove that they will not interfere with any potential Part 15 devices that may (or may not) be affected by their operations. This amounts to having to "prove a negative." Rather than requiring Part 15 device operators to prove that they are receiving harmful interference, the field-testing provision requires licensees to prove that they will not cause harmful interference to any Part 15 users – in the total absence of any technical parameters from those Part 15 users.

Moreover, the imposition of the requirement solely upon licensees turns the regulatory hierarchy in the band entirely upon its head. Under Part 15, unlicensed devices must accept interference from users that are higher in the band hierarchy, including in this case the M-LMS licensees. Putting the burden of preventing harmful interference solely upon the licensees – and moreover, requiring those licensees to prove they will not interfere with an unknown quantity, *before* they can deploy their systems – inverts the regulatory pyramid, essentially placing unlicensed manufacturers and users in a superior position to licensees in a way that the Part 15 Rules never contemplated.

Progeny fully supports the goals of establishing coexistence between licensees and unlicensed entities in the band. Progeny also believes, however, that such coexistence involves all parties. Part 15 manufacturers and unlicensed system operators should not have a blank check to engage in spectrally inefficient behavior, any more than the M-LMS licensees should. The obligation to engage in "good citizen" behavior as users of spectrum – a public asset – does not disappear in the unlicensed environment. Therefore, the testing requirement should be eliminated, and replaced by provisions urging parties to publish information on their technical specifications. Asking the Part 15 community, as well as M-LMS licensees, to be forthcoming regarding their technical specifications and deployments will resolve the current imbalance, in which Part 15 manufacturers and users have no incentive to collaborate or coordinate with other users in the band. If the right rules are in place, M-LMS licensees such as Progeny will be able to offer advanced, location-based services, such as Progeny's planned EPL offering, which will serve the public interest and promote economic growth, public safety and spectral efficiency.

Moreover, as discussed in Sections II and III, above, Progeny believes it will cause less potential interference than any Part 15 device might receive from another Part 15 device. Given this evidence of technical compatibility in the band, M-LMS licensees and Part 15 devices will be able to coexist and flourish in the 902-928 MHz band without any need for burdensome testing requirements.

V. Conclusion

Progeny urges the Commission to eliminate its current M-LMS service restrictions and other outdated rules in the 902-928 MHz band, including the spectrum aggregation limit and the unilateral field-testing obligation. It is clear that the Commission's intent for this band has never wavered. The Commission has always acted in this band with the intention to promote the growth of advanced location-based services while preserving a balance of licensed and unlicensed uses. In its NPRM, the Commission is re-affirming those goals for this band. Progeny wholeheartedly supports those goals and lauds the Commission for the consistency of its vision and its willingness to re-examine the regulatory tools it has employed to achieve it.

Progeny submits that those tools have proven, through no fault of the Commission, to be inadequate for the job. Ultimately, the key to harmonious use of the 902-928 MHz band is the mitigation of potentially harmful interference among all uses, including licensed services and Part 15 devices. But the Commission's service restrictions, spectrum cap and testing obligations were never more than surrogates for interference avoidance. Rather than promoting the use of spectrally efficient technologies by all users, they effectively barred M-LMS licensees from finding any market for their narrowly prescribed services, while giving Part 15 devices unwarranted shelter from the need to deploy more advanced, efficient technologies.

In the intervening years, it has become clear that relaxing service restrictions and granting regulatory flexibility can pay huge dividends in the growth of marketable and valuable services. In this case, there is a strong market for homeland security and public safety services with location-based capabilities. Licensees need regulatory flexibility to address that market, and the public will benefit directly as a result.

Moreover, the Commission no longer needs to use command-and-control restrictions as proxies for interference mitigation. The wireless industry has developed much more efficient transmission and antenna technologies, and more robust receivers. Technology now exists to use spectrum more wisely, more efficiently and more effectively. This drive for technological innovation is at the heart of the Commission's policies on unlicensed usage. What's needed at this juncture is a clear, consistent policy of incentives in this band for more efficient spectrum usage under Part 15 – not a lingering legacy of artificial protection for older technologies. The Commission can align the 902-928 MHz band with its regulatory flexibility and Part 15 policies, which have come to the fore during this decade as viable and forward-looking. The Commission is fully entitled to do so in this proceeding. It is manifestly in the public interest to do so.

In the process of granting flexibility to licensees and fostering more efficient spectrum usage, the Commission can pave the way for innovative new services –including Progeny's EPL and overlay networking offerings. These services offer direct benefits to the public, through homeland security and public safety applications, in uncertain times. And they free up all parties to explore synergies between the licensees' capabilities and the innovative potential of Part 15 use. The future is one of possibilities, offset against a present of stalled growth and technical stagnation. Progeny strongly urges the Commission to take the next step on its ongoing path of fostering the best, highest use of this band.

Progeny, therefore, hereby submits its comments and pledges to continue working with the Commission and all concerned parties to develop a full record in this proceeding and to ensure that the spectrum in the 902-928 MHz band is put to full and productive use.

Respectfully,

_/s/ Janice Obuchowski________________
Janice Obuchowski
Counsel
Progeny LMS, LLC

May 30, 2006

Certificate of Service

I, Mary Greczyn, hereby certify that I have, on this 30th day of May 2006, emailed a copy of the foregoing *Comments* to the following:

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Appendix A

White Paper

LMS Compatibility with Part 15 Devices:
The Case for Spectrum Flexibility

Contents

Exhibit 6. Calculation of Interfering Power: Cordless

Introduction

This White Paper was prepared on behalf of Progeny LMS, LLC, in support of its Petition for Rulemaking (RM-10403), filed on March 5, 2002. The paper seeks to provide a technical framework for addressing an area of concern raised by companies filing comments in this proceeding. That concern, stated as a question, is:

> Will additional flexibility for LMS systems cause unacceptable levels of interference to Part 15 devices?[49]

This paper presents the technical design parameters of a Location and Monitoring Service (LMS) network and analyzes several real-world cases of interference Part 15 devices. The technical framework described in this paper, and the specific interference scenarios presented, is intended to be illustrative, using reasonable assumptions about technical parameters and deployment scenarios. Given the wide range of Part 15 devices, an exhaustive interference analysis is beyond the scope of this paper.

This paper demonstrates, however, that additional flexibility for LMS systems will not cause an unacceptable level of interference to Part 15 devices. This paper further demonstrates that even "high-density" [50] LMS systems do not present an interference risk to Part 15 devices that is greater than the inherent interference risk already present from other Part 15 devices.

LMS Network Parameters

This section defines the fundamental engineering parameters that must be considered when designing and deploying an LMS network. Nominal values are established for all of the parameters based on industry standard practices and extensive experience in real world deployments.

The network parameters – and their nominal values as established in this paper – are intended to provide a framework for assessing both the performance and potential interference risks associated with a general purpose, flexible LMS network. In some cases, severe interference cases are examined in order to facilitate a high-confidence, conservative analysis.

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[49] *Unless explicitly noted to the contrary, all references to Part 15 devices in this paper are to devices operating in the 902-928 MHz band. All references to LMS systems in this paper are to Multilateration LMS systems.*

[50] *"High-density" LMS systems are described below as systems deployed extensively enough to provide a high degree of in-building service. These high-density LMS systems are believed to present the worst case interference risk to Part 15 devices.*

These cases are intended to provide worst-case examples and are not proposed as a litmus test for Part 15 protection.

VI. Potential LMS Services

In order to evaluate the potential impact to Part 15 devices from an LMS network, the parameters of a hypothetical LMS network are described below. To consider the worst-case LMS impact to Part 15 devices, a "high-density" LMS network is utilized, i.e., a network with sufficient base station density to provide in-building coverage. While LMS may have originally been considered primarily a vehicular service (which would not require in-building service) many LMS applications may indeed require such service ubiquity. Tracking inventory, enabling delivery confirmations and receiving telemetry from meters or vending machines are just a few examples. Of course, some LMS providers may deploy lower density networks to effectively provide vehicular or other services, but the LMS network described in this paper represents the maximum impact on Part 15 that an LMS network could reasonably be expected to cause.

LMS systems will likely deploy packet data networks to provide LMS services. Such LMS services may include tracking vehicles, equipment, inventory and packages for business, public safety and personal applications. These LMS services will involve "bursty" data transmissions. Ancillary voice service, most likely carried as IP packets ("voice over IP" or VoIP), may be an important component of LMS service offerings. However, LMS is not expected to be another cellular voice service. The cellular voice market already has too many competitors and financing yet another entrant is very unlikely. Instead, Progeny expects LMS systems to carry location data, identification information, status data, source/destination information, schedule information, expiration information, price information, ancillary voice traffic, imaging data, dispatching information, software updates and remote troubleshooting information.

VII. Deployment Configurations for an LMS Network

In order to provide ubiquitous coverage and control costs, an LMS network will likely utilize existing structures for base station deployments. In urban areas, a typical LMS base station will be deployed on building rooftops. High-gain directional antennas will be used to achieve the allowed 30 watt ERP and maximize uplink coverage. Typically, this will involve a three-sector configuration with two antennas in each sector for receive diversity. Actual antenna deployments are dependent on the system architecture. Generally, it is economical to duplex transmit and receive functions into one or both sectorized antennas to minimize the number of antennas, since rooftop rents usually increase with additional antennas. For some architectures, it is desirable to use low noise amplifiers (LNAs) at the receive antennas to maximize uplink coverage.

In suburban areas, LMS systems will typically use building rooftops, where sufficiently tall buildings are available, or existing monopoles and tower structures. For this evaluation, collocation on an existing monopole is assumed. Generally, suburban deployments will also involve three-sector configurations with similar antenna deployments as urban environments.

For this evaluation, a Decibel Products DB876G90A-XY panel antenna with 16 dBi gain and a 90° horizontal beamwidth is utilized. This antenna represents a typical antenna that could be utilized for an LMS network deployment. The antenna specification sheet is attached as Exhibit 1.[51] The antennas used in this analysis are mechanically downtilted, so that the 3 dB point above the main lobe on the antenna's vertical pattern is oriented at the base station coverage boundary (at the radius of the hexagonal "cell"). Antenna downtilting, particularly in urban areas, is a practical means of maximizing coverage and minimizing interference.

VIII. Link Budgets

A link budget examines transmitted power, gains and losses in the transmission path to determine the base station coverage radius. Link budgets are examined for both the downlink (or forward link) from the base station to the mobile device and the uplink (or reverse link) from the mobile device to the base station. A typical link budget for the downlink in an urban environment is presented below:

Urban Link Budget
Downlink (base station to mobile)

		Watts
Transmitter power output	33.9 dBm	2.5
Transmission line/connector losses	3.0 dB	
Antenna input power	30.9 dBm	1.2
Antenna gain	16.0 dBi	
Effective Isotropic Radiated Power (EIRP)	46.9 dBm	49.2
Effective Radiated Power (ERP)	44.8 dB	30.0

[51] *More information can be obtained at www.decibelproducts.com.*

	m	
Building penetration loss	15.0 dB	
Mobile device antenna gain	2.2 dBi	
Mobile device antenna connector loss	0.2 dB	
Interference margin	12.0 dB	
Receiver threshold	-105.0 dB m	
Maximum propagation loss	126.9 dB	

LMS systems are allowed a maximum of 30 watts ERP in 95% of the licensed frequencies. The remaining 5% of the licensed frequencies (927.25-928 MHz) are allowed 300 watts ERP on the forward link. The analyses presented in this paper pertain only to the portion of the LMS spectrum with the 30 watt ERP limit. The remaining portion of the licensed LMS spectrum constitutes less than 3% of the total 902-928 MHz band, and it is believed that the interference impact to Part 15 devices of the higher power in this portion of the band is minimal. Such an analysis is beyond the scope of this paper.

As can be seen from the link budget figures, the 16 dBi gain antenna allows an LMS base station to meet its 30 watt ERP limit with a 2.5 watt transmitter. This calculation assumes a 3 dB loss in the transmission line and connectors, which is typical for rooftop installations. It should be noted that EIRP (power relative to an isotropic antenna) is higher than ERP (power relative to a dipole), by the gain of a dipole antenna relative to an isotropic antenna, i.e., 2.15 dB.

Although building penetration losses vary widely from building to building, an allowance of 15 dB for building penetration loss in an urban area is consistent with experience at 900 MHz for ubiquitous mobile systems. This building penetration factor has a significant impact on base station coverage and thus the number of base stations required to serve a given area. This assumption is consistent with the “high-density” LMS network for examining maximum impact to Part 15 devices. In some of the interference scenarios presented later, a lower building penetration loss (6 dB) is used to analyze the worst-case scenario of interference to a Part 15 device located near the window of an office building. This assumption is also consistent with experience at 900 MHz.

Other factors used in the link budget calculation also represent reasonable assumptions. The mobile device is assumed to have a half-wave dipole antenna and a small connector loss. There is a wide range of possibilities for LMS mobile units, but for purposes of link budgeting, a portable device in a building with a dipole antenna represents a good design assumption. The interference margin is included recognizing the “noisy” RF environment in the 902-928 MHz band; fade margin is included in the interference margin figure.

The receiver threshold is the minimum signal power necessary for acceptable performance of the receiver for a given quality specification, such as bit error rate. Receiver threshold is dependent upon the thermal noise, which is dependent upon the signal bandwidth, and the noise figure of the receiver, which is dependent upon the design and manufacturing of the receiver. Over the range of possible LMS signal bandwidths, signal modulations, performance requirements and cost factors, the assumed receiver threshold is consistent with receiver thresholds for other 900 MHz devices.

The maximum propagation loss is calculated from the factors discussed above. Since propagation loss increases with distance, this figure allows us to determine the maximum coverage radius of the base station. Before making that determination, it is necessary to examine the uplink link budget. If the maximum propagation loss for the uplink is less than the downlink, then base station coverage is limited by the uplink.

Urban Link Budget
Uplink (mobile to base station)

		Watts
Transmitter power output	30.9 dBm	1.2
Antenna connector loss	0.2 dB	
Antenna input power	30.7 dBm	1.1
Antenna gain	2.2 dBi	
Effective Isotropic Radiated Power (EIRP)	32.9 dBm	1.9
Effective Radiated Power (ERP)	30.7 dBm	1.2
Building penetration loss	15.0 dB	
Base station receive antenna gain	16.0 dBi	
Transmission line/connector losses	3.0 dB	
Interference margin	12.0 dB	
Receiver threshold	-108.0 dBm	
Maximum propagation loss	126.9 dB	

This budget uses the same assumptions as the downlink, with the exception of the mobile device transmitter power and receiver threshold. In general, there are many more mobile devices than base stations and it is desirable to keep mobile device costs low. While low cost is also desirable for base stations, it is practical to have better performing, more expensive receivers at the base stations. Better base station performance minimizes the number of base stations required for ubiquitous service, lowering overall system costs. Consequently, the base station receiver sensitivity is assumed to be 3 dB lower than the mobile device threshold.

Since there are many possible types of LMS mobile devices, the 1.2 watt transmitter is a reasonable assumption. Some types of LMS mobile devices might utilize higher-power transmitters. For LMS systems supporting those devices, higher-gain mobile device antennas or better mobile receiver performance would allow larger base station coverage areas. Some LMS devices, such as those used regularly in close proximity to the human body, might utilize lower power transmitters. LMS systems supporting those types of devices might utilize receive antenna LNAs to equalize the uplink and downlink link budgets.

Under the link budget assumptions discussed above, the maximum propagation losses are the same for the downlink and the uplink.

For suburban environments, a building penetration factor of 10 dB is used. This factor is consistent with the high-density LMS network assumption and consistent with building loss assumptions for other 900 MHz networks.

Suburban Link Budget
Downlink (base station to mobile)

			Watts
Transmitter power output	33.9	dBm	2.5
Transmission line/connector losses	3.0	dB	
Antenna input power	30.9	dBm	1.2
Antenna gain	16.0	dBi	
Effective Isotropic Radiated Power (EIRP)	46.9	dBm	49.2
Effective Radiated Power (ERP)	44.8	dBm	30.0
Building penetration loss	10.0	dB	
Mobile device antenna gain	2.2	dBi	
Mobile device antenna connector	0.2	dB	

loss		
Interference margin	12.0 dB	
Receiver threshold	-105.0 dBm	
Maximum propagation loss	131.9 dB	

Again, with these assumptions, the maximum propagation loss is the same for uplinks and downlinks.

Suburban Link Budget
Uplink (mobile to base station)

		Watts
Transmitter power output	30.9 dBm	1.2
Antenna connector loss	0.2 dB	
Antenna input power	30.7 dBm	1.1
Antenna gain	2.2 dBi	
Effective Isotropic Radiated Power (EIRP)	32.9 dBm	1.9
Effective Radiated Power (ERP)	30.7 dBm	1.2
Building penetration loss	10.0 dB	
Base station receive antenna gain	16.0 dBi	
Transmission line/connector losses	3.0 dB	
Interference margin	12.0 dB	
Receiver threshold	-108.0 dBm	
Maximum propagation loss	131.9 dB	

IX. Propagation Models

C. Outdoor Propagation Model

To calculate the base station coverage area, a propagation model is selected that is appropriate for this type of network. Several industry standard propagation models were examined, and the COST-Walfisch-Ikagami-Model (COST-WI)[52] was selected. The Wireless Communications Technology Group (WCTG) of the National Institute of Standards and Technology describes this model as follows:

[52] *See "Digital Mobile Radio Towards Future Generations, Cost 231 Final Report", chapter 4, pages 135-140 (Cost 231 Final Report). This can be found at www.lx.it.pt/cost231.*

> "In Europe, research under the Cooperation in the Field of Scientific and Technical Research (COST) program has developed improved empirical and semi-deterministic models for mobile radio propagation. In particular, Project 231 (COST 231), entitled 'Evolution of Land Mobile Radio Communications,' resulted in the adoption of propagation modeling recommendations for cellular and PCS applications by the International Telecommunications Union (ITU), including a semi-deterministic model for medium-to-large cells in built-up areas that is called the Walfisch-Ikegami model. The Walfisch-Ikagami model (WIM) has been shown to be a good fit to measured propagation data for frequencies in the range of 800 to 2000 MHz and path distances in the range of 0.02 to 5 km."[53]

The COST-WI model uses parameters for building heights, road widths, building separations and road orientations to characterize the RF environment. The model distinguishes between line-of-sight (LOS) and non-line-of-sight (NLOS) cases with different propagation formulas. Based on measured data analyses, the formula for LOS cases is different from free-space path loss using a distance term to the power of 2.6 rather than distance squared. The NLOS case uses a term for free-space path loss, a term for rooftop-to-street diffraction and scatter loss, and a term for multiple screen diffraction loss.

The following parameters were used for the urban environment:

Urban Environment Parameters

LMS base station antenna height	(h_{base})	200 ft AGL[54]	61.0 m AGL
LMS mobile device antenna height	(h_{mobile})	6 ft AGL	1.8 m AGL
heights of buildings	(h_{roof})	180 ft AGL	54.9 m AGL
widths of roads	(w)	50 ft	15.2 m
building separation	(b)	100 ft	30.5 m
road orientation	(φ)	90 degrees	

Similarly, the following parameters were used for the suburban environment:

Suburban Environment Parameters

LMS base station antenna	(h_{base})	150 ft AGL	45.7 m AGL

[53] *See w3.antd.nist.gov/wctg/manet/calcmodels_dstlr.pdf*
[54] *Above Ground Level.*

height			
LMS mobile device antenna height	(h_{mobile})	6 ft AGL	1.8 m AGL
heights of buildings	(h_{roof})	35 ft AGL	10.7 m AGL
widths of roads	(w)	60 ft	18.3 m
building separation	(b)	120 ft	36.6 m
road orientation	(φ)	90 degrees	

These parameters are intended to represent the typical deployment of an LMS system in an urban environment and a suburban environment, respectively. In the urban environment, LMS antennas are assumed to be pole-mounted on a rooftop structure allowing the antennas to "see" over the building edge. Surrounding buildings are assumed to be 180 feet tall (approximately 15 stories), with typical road widths and building separations. Likewise, in the suburban environment, LMS antennas are assumed to be mounted on existing monopole structures. Surrounding buildings are assumed to be 35 feet tall (representing homes and retail stores), with typical road widths and building separations. Road orientation is the angle with respect to the direct radio path. Since we are examining the general case, the COST 231 recommended value of 90° is used. Terrain effects are not considered in this analysis.

D. Indoor Propagation Model

A propagation model appropriate for the indoor environment is needed to calculate the interfering power that one Part 15 device (e.g., a WLAN access point) might see from another Part 15 device in the same building. Several industry standard models were evaluated and the COST 231 One Slope Model (1SM)[55] was selected because it applies to all building types and matches well with empirical data. Ray tracing models are considered too computationally intensive and too site-specific for this general interference analysis.

The 1SM formula is:

$$L = L_0 + 10 * n * \log (d)$$

where:

L is the propagation loss in dB
L_0 is the path loss at 1 m
n is the power decay index

[55] *See Cost 231 Final Report, chapter 4, pages 176-179.*

d is the distance in m

The factors L_0 and n are based on measured data and supplied for various environments.

X. LMS Base Station Coverage and Density

To determine the density of LMS base stations necessary to cover an area, a theoretical hexagonal base station grid is assumed. Actual deployments, of course, never precisely fit this grid pattern, but it is a reasonable assumption for approximating the number of base stations required for coverage. Using the coverage radius as the distance from the hexagon's center to a vertex allows for some coverage overlap on each of the hexagon's side. The hexagon then describes the unique coverage area of each base station.

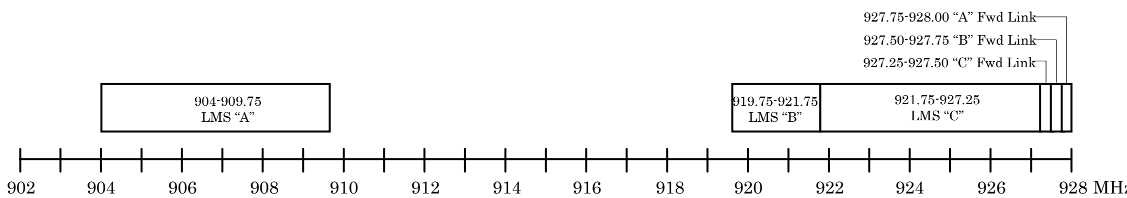
Using the COST-WI model with the assumptions outlined above, the high-density urban base station coverage radius was calculated to be 0.27 miles (0.44 kilometers), yielding an equivalent coverage area of 0.19 square miles, or 5.2 LMS base stations per square mile. Likewise, the high-density suburban base station coverage radius was calculated to be 2.2 miles (3.6 kilometers), yielding an equivalent coverage area of 13.0 square miles and a density of less than one LMS base station every 10 square miles.

Interference Analysis

XI. Band Occupancy

Part 15 devices must operate in an uncontrolled environment in which other Part 15 devices are present, making interference a fact of life in the 902-928 MHz band. Devices deployed in this band are designed to tolerate such an environment and may employ frequency agility to avoid interfering sources. Frequency agile architectures such as frequency hopping (FH) and digitally modulated (DM) spread spectrum are tolerant of nearby interfering sources. In an FH system, for example, interference from another FH system is the statistical likelihood that the two systems transmit on the same frequency at the same time. Interfering power in a portion of the band not used at that exact moment does not negatively impact performance of a Part 15 device.

The fact that multilateration LMS spectrum constitutes only about half of the 902-928 MHz band (see below) is a major factor in minimizing potential interference to Part 15 devices. For FH and other frequency-agile Part 15 devices, there is no possibility of collisions with multilateration LMS transmissions in nearly half the band; the same is not true of other Part 15 devices.



Another factor minimizing potential LMS interference to Part 15 is the nature of traffic in the band. Part 15 devices, as well as the services envisioned for LMS networks, rely on bursty data transmissions, which inherently experience lower collision rates. In addition to being bursty, many Part 15 devices in this band, such as some automatic meter reading and telemetry devices, are also low data-rate devices that are designed to transmit and retransmit until the data is successfully received. Finding a channel that is unoccupied for a sufficient duration to transmit and receive acknowledgement might require retransmissions in the presence of interfering signals. For higher data rate devices, many automatically reduce their data rates as the carrier-to-interference ratio becomes degraded.

XII. Interference Scenarios

The interference scenarios examined below are based on reasonable assumptions. It is recognized that catastrophic interference cases could be devised, but Part 15 is not an environment in which interference protection from outlying cases is expected. Indeed, the Commission addressed the issue of absolute interference protection to Part 15 in the LMS proceeding:

> “The language in the Order on Reconsideration cited by Pinpoint does not mean that Part 15 devices are entitled to protection from interference. They are not.”[56]

Instead, when reasonable assumptions demonstrate that LMS networks will not create interference risks to Part 15 devices significantly greater than the inherent risks from other Part 15 devices, then it is clear that LMS networks will not cause unacceptable levels of interference to Part 15 devices.

FH and DM Part 15 devices operating under Section 15.247 of the FCC Rules are allowed 1 watt maximum peak output power and a 6 dBi antenna. Thus, these devices can operate with 4 watts (36.0 dBm) EIRP. The maximum Part 15 EIRP calculation is shown below.

Part 15 Maximum EIRP Calculation

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[56] *Memorandum Opinion and Order and Further Notice of Proposed Rulemaking, Docket 93-61, September 16, 1997, paragraph 69.*

		Watts
Transmitter power output	30.2 dBm	1.1
Antenna connector loss	0.2 dB	
Antenna input power	30.0 dBm	1
Antenna gain	6.0 dBi	
Effective Isotropic Radiated Power (EIRP)	36.0 dBm	4.0

Comparing maximum power levels, LMS systems are allowed 46.9 dBm EIRP which is 10.9 dB higher than the FH and DM Part 15 devices. At first blush it might appear than LMS systems will present a greater interference threat than other Part 15 devices, but as we will see, the effect of the larger LMS EIRP is reduced by the antenna's vertical radiation pattern and balanced by the proximity and number of Part 15 devices.

In analyzing potential interference from an LMS base station, the vertical pattern of the antenna is utilized. The maximum ERP occurs on the main lobe of the vertical pattern. Radiation at any other elevation angle is reduced from the maximum. A tabulation of the antenna's vertical radiation pattern from the manufacturer was used in these analyses.

As stated above, base station antennas are typically mechanically downtilted to utilize the radiated power in the service area and reduce potentially interfering radiation towards other base station coverage areas. The 3 dB point above the main lobe of the antenna's vertical pattern was oriented towards the coverage boundary. Using the assumptions outlined above, for the urban environment, the optimum antenna downtilt was determined to be 12°. Applying a similar analysis to the suburban environment, the optimum antenna downtilt was determined to be 5°.

In a three-sector configuration, the angle between sector orientations is 120°. Using 90° horizontal beamwidth antennas, the ERP is slightly reduced in directions between sector orientations. Theoretically, this would reduce the base station's radiated power in those directions. However, experience in urban deployments has shown improved performance using 90° antennas over 120° antennas. In order to make this analysis conservative, the effects of the horizontal antenna pattern are not considered. Reductions in ERP in any direction (combination of azimuth and elevation angle) are only due to the antenna's vertical pattern. The maximum ERP is assumed at all azimuths on the main lobe of the antenna's vertical pattern.

E. Wireless Local Area Networks

Several commenters in this proceeding (Agere, Intermec, WaveRider and the License-Exempt Alliance) have expressed concern about interference protection of Part 15 Wireless Local Area Network (WLAN) and internet access products. WiFi (802.11) products, which operate in the 2.4 and 5 GHz bands, not the 902-928 MHz band, constitute the overwhelming majority of devices sold for these purposes. Indeed, reviewing the Agere and Intermec Web sites, it is clear that these manufacturers are promoting WiFi equipment and components. WaveRider, which also has a 2.4 GHz product, has less than 100 customers in the United States. While it is clear that WLAN products have moved to higher frequency bands, an interference analysis is included which is applicable to legacy systems and possibly other types of Part 15 devices.

An interference analysis for WLANs is made in the urban environment, assuming business customers have purchased these products. Wireless home networking has been highly successful with the availability of WiFi products, and thus it is assumed that very few 915 MHz WLANs are being deployed in suburban neighborhoods. For a 915 MHz WLAN deployed in an urban office building, there will be an impact from other Part 15 devices in the area. There is no protection against other Part 15 devices being deployed in the same building, on the same floor, in adjacent buildings and outside the building.

Although FH and DM Part 15 devices are allowed a maximum EIRP of 4 watts, Part 15 products designed to operate in an indoor office environment typically operate at a lower EIRP. To account for typical lower operating powers, we have assumed an EIRP reduced 12 dB below the allowed maximum. As shown below, this results in an EIRP used in this analysis of of 0.25 watts.

Part 15 Reduced EIRP Calculation

			Watts
Transmitter power output	18.2	dBm	0.07
Antenna connector loss	0.2	dB	
Antenna input power	18.0	dBm	0.06
Antenna gain	6.0	dBi	
Effective Isotropic Radiated Power (EIRP)	24.0	dBm	0.25

To evaluate the impact of one Part 15 device on another, we consider the case of a WLAN deployment in an urban office building with another FH or DM Part 15 device (INT device) deployed one floor directly below the WLAN access point. This seems to be a case that a Part 15 WLAN deployment might reasonably encounter. For this analysis we consider a WLAN access point (AP) located in the middle of the building, 20 feet from the building exterior, a workstation (WS1) located in a nearby office 10 feet closer to the building exterior, and another workstation (WS2) in an office located 10 feet further from the building exterior.

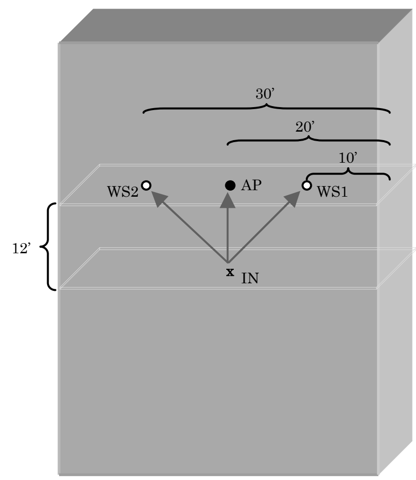


Figure 1. The reduced power interfering Part 15 device (INT) is located one floor immediately below the WLAN access point (AP) and 10 feet horizontally offset from two WLAN workstations (WS1 and WS2).

We use the 1SM indoor propagation model with the "two floors" factors.[57] There is no frequency adjustment to L_0 for the "two floors" case. We have assumed 12 feet per floor. A comparison between the 1SM path loss and free space path loss is also provided. The power decay is distance to the 5.2 power as compared to distance squared in the free-space path loss. For AP we assume a 6 dBi antenna gain is used to maximize WLAN coverage in the office space. For WS1 and WS2 we assume that the workstations use a wireless modem card with an antenna gain of 2.15 dBi. These are reasonable assumptions, but in a comparison of interfering power levels, the actual antenna gains are immaterial since both interfering sources are received by the same antenna.

We do not include vertical pattern effects of the Part 15 devices. For these antennas, the vertical patterns are extremely broad and the orientation of these antennas in an indoor office environment is unknown. Furthermore,

[57] *For this model, one floor means the same floor, two floors means adjacent floors and multi-floor means more than two floors.*

due to the nature of indoor propagation, the effect of the vertical radiation pattern would be very difficult to model, even with a complex ray tracing analysis and a detailed physical model of the office. Certainly, for this analysis using very low gain antennas, assuming the maximum antenna gain from the Part 15 devices is reasonable.

Exhibit 2 (attached) shows the interfering powers received at WS1, AP and WS2 from the INT device.

To compare the interfering power from the LMS system with the Part 15 interfering power, we examine the case where the WLAN is in the building across the street from, and in line-of-sight of, the LMS base station. We examine cases where the WLAN is 100, 125, 150 and 175 feet above ground level (Figure 2). This is considered to be a severe interference case.

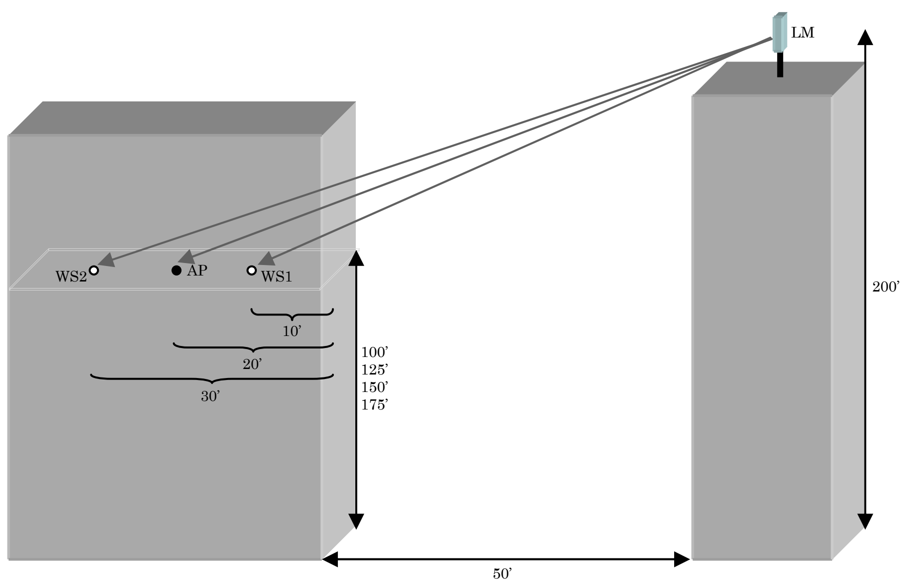


Figure 2. An LMS antenna mounted on the roof a building immediately across the street from a WLAN deployment. Interference is calculated at different heights of the WLAN deployment.

For this case, we use the COST-WI LOS mode with a 15 dB building penetration loss applied to AP and WS2. For WS1, which is located in an exterior office with a window, we assume only a 6 dB penetration loss. We use the vertical radiation pattern of the LMS base station because it is a high-gain antenna that has been engineered with mechanical downtilt and professionally installed.

Exhibit 3 (attached) shows the calculation of the interfering power levels received at WS1, AP and WS2 from the LMS base station.

Comparing Exhibits 2 and 3, the interfering power level of the INT device one floor below the WLAN is higher than the LMS interfering power level in all virtually cases. The interfering power level from the INT device at AP is greater than that from the LMS base station by as much as 35.6 dB. Even for the AP located 175 feet AGL, the interfering signal from the INT device is 8.4 dB higher. For WS1, which is in an office with a window across the street from the LMS base station, the interfering power level from the INT device is higher in all cases and by as much as 24.6 dB. For WS2, the interfering power level from the INT device is as much as 21.0 dB higher. Only in the case of WS2 located 175 feet AGL, is the interfering power level from the LMS base station higher than that from the INT device. In that case, the difference is less than 0.5 dB.

It should be noted that this interference case using offices across the street from the LMS base station is a severe test and should not be the standard by which LMS systems are held. LMS systems should not be expected to provide absolute interference protection. If, over the vast majority of the coverage area, LMS systems do not prevent Part 15 devices from being deployed and operating as they might reasonably be expected to operate, then LMS systems have not caused an unacceptable level of interference to Part 15 devices.

From an examination of the relative interfering powers, we conclude that even in a severe interference case, the LMS base station does not present interfering power levels significantly greater than interfering power levels from other Part 15 devices. When coupled with band occupancy considerations, we conclude that LMS base stations will not cause an unacceptable level of interference to Part 15 devices.

F. Ricochet

Ricochet also filed comments in this proceeding expressing concerns about interference from LMS systems.[58] Aerie Networks purchased the Ricochet assets from Metricom, Inc., which filed for bankruptcy in July 2001. It is believed that Denver, CO is the only city in the country where the Ricochet service is available. An interference case to the Ricochet Pole Top Radio (PTR) is described below.

Ricochet uses a FH technology in the 902-928 MHz band for the system uplink, that is, from subscriber modem cards to the PTR. The 2.4 GHz band is used from the PTR to the Wired Access Point (WAP) and thus is outside the band of interest. For this calculation, we have assumed the PTR is on a

[58] *Ricochet Networks, Inc.*

utility pole 15 feet AGL in the urban environment (Figure 3). We assume that another FH or DM Part 15 device with reduced EIRP is in an office with a window overlooking the PTR, 500 feet' away. Because of the urban clutter and the height difference, we assume that the LMS base station, separated 500 feet horizontally, does not have LOS propagation to the PTR.

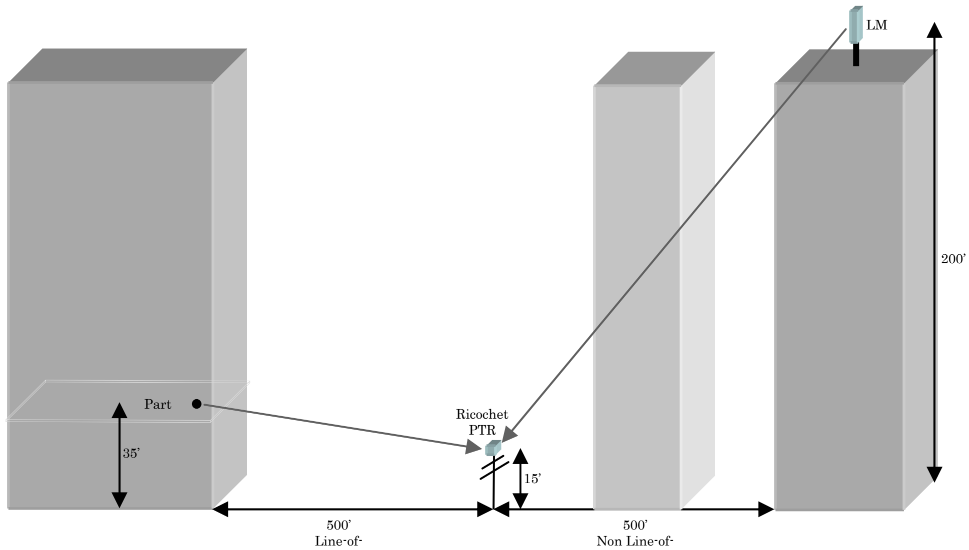


Figure 3. A Ricochet Pole Top Receiver (PTR) receives interference from a reduced power line-of-sight Part 15 device and a non-line-of-site LMS antenna.

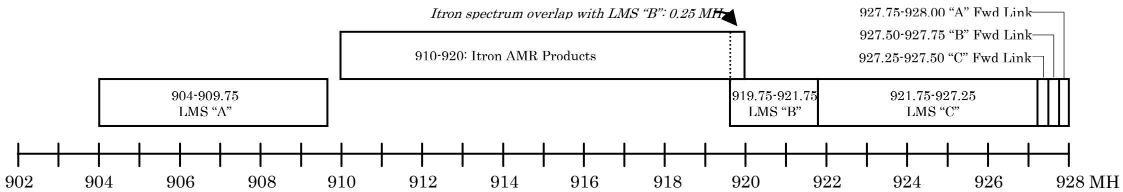
Exhibit 4 shows calculations comparing the interfering power levels at the PTR from another Part 15 device and from the LMS system. For the Part 15 device we have used the COST-WI LOS model plus a 6 dB penetration loss through the office window. With those assumptions, the Part 15 device produces an interfering power level of –59.6 dBm. Using the COST-WI NLOS model for the LMS base station, the LMS interfering power level is –71.6 dBm. In this scenario, the PTR experiences an interfering power level from the Part 15 device that is 12.0 dB higher than the interfering signal from the LMS base station.

G. Automatic Meter Readers

Several commenters in this proceeding (Itron Inc., Axonn, LLC and SchlumbergerSema Inc.) have expressed concern about interference protection of Part 15 Automatic Meter Reading (AMR) devices. Interestingly, a review of Itron's product line reveals that these products operate in the 910-920 MHz band.[59] As can be seen from the chart below, there is virtually no overlap between Itron's products and licensed spectrum for multilateration

[59] *The MAS band frequencies (952 MHz and 957 MHz) are used by some Itron products but these frequencies are outside the band of interest.*

LMS (0.25 MHz out of 10 MHz). Consequently, no interference to Itron's product is expected from LMS operations.



The majority of Axonn's product line appears to be programmable in eight 3 MHz steps across the 902-928 MHz band. Since that covers the entire band, it would also appear that Axonn products can operate entirely outside the LMS spectrum. SchlumbergerSema's Utilinet product is an FH device using 240 25 kHz channels in the 902-928 MHz band. This product is well designed to operate in an interference environment. The Network Performance Statistics include such parameters as the number of retries required to move a message to the next radio and the percentage of successful deliveries. According to the product brochure under Automatic Collision and Contention Management:

> "Should a message ever be blocked by interference on a given frequency, the radio automatically hops to a different frequency and tries again."

The impact of interfering power from an LMS system is to increase collisions on Utilinet frequency hops in the LMS half of the band when the bursty LMS transmissions happen to fall on the same frequency. The net impact is a potential increase in Utilinet re-transmissions; exactly the same effect is present from other Part 15 devices.

To compare the interfering power at a meter reading device from another Part 15 device and an LMS base station, we assume the meter is in a suburban home (Figure 4). We assume that the meter transmits when polled by a nearby handheld or vehicle mounted device. We assume that the AMR device is 6 feet AGL.

As outlined above, in the suburban environment, the LMS base station density is less than one for every 10 square miles. It is reasonable, therefore, to assume that on average other FH or DM Part 15 devices will be in much closer proximity to the AMR device. We assume that such a Part 15 device is located 0.1 mile away, mounted above the shopping center roof, 50 feet AGL. For this suburban case, we assume that the Part 15 device is not one designed to operate in the indoor office environment. This interfering Part 15 device is assumed to be providing a "campus" type service covering the entire shopping center. For such a device, we assume the maximum allowed EIRP for the Part 15 device. As stated above, in the suburban environment, we assume that the LMS base station is located 150 feet AGL on an existing monopole. We assume that the monopole is 0.5 mile away. We use the COST-WI NLOS model for both the Part 15 device and the LMS base station.

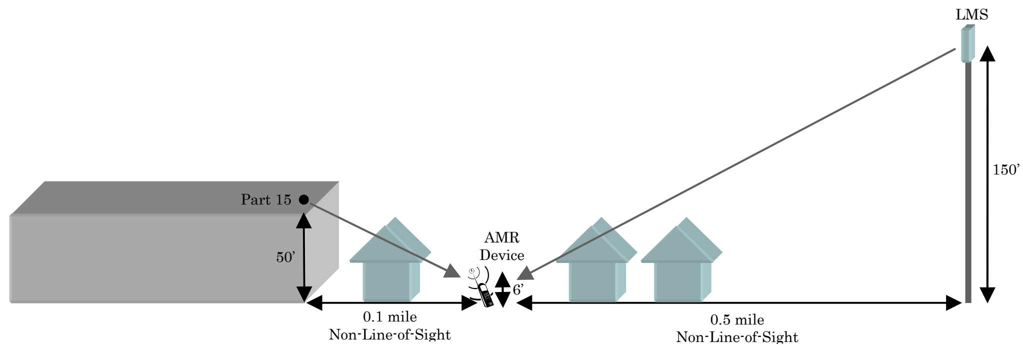


Figure 4. An Automatic Meter Reading (AMR) device receives non-line-of-sight interference from a Part 15 device located on a suburban shopping mall rooftop, and from an LMS antenna located on a nearby monopole.

As can be seen in Exhibit 5 (attached), under these assumptions, the interfering power from the Part 15 device is –57.1 dBm. The interfering power from the LMS base station is –58.5 dBm. Thus, the interfering power from the Part 15 device is higher than that from the LMS base station. At these heights and distances, the AMR is in the main lobe of the Part 15 antenna, so there are no vertical pattern effects. As can be seen in Exhibit 5, the effect of the LMS vertical pattern is minimal.

H. Cordless Telephones

A similar calculation is made to a Part 15 cordless phone located inside the home (Figure 5). In this case, a 10 dB home penetration factor is added to both interfering signal levels and we assume the cordless phone at 15' AGL.

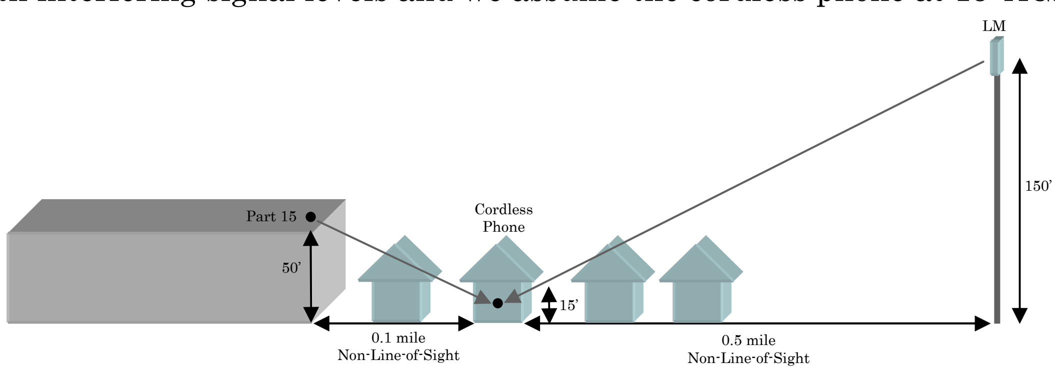


Figure 5. A residential cordless phone receives non- line-of-sight interference from a Part 15 device located on a suburban shopping mall rooftop, and from an LMS antenna located on a nearby monopole.

As can be seen in Exhibit 6 attached, the interfering power from the Part 15 device is –63.8 dBm, while the interfering power from the LMS base station is –65.9 dBm. Thus, the interfering power from the Part 15 device is higher than that from the LMS base station.

I. LMS Mobile Devices

LMS mobile devices also present a potential interference source within the 902-928 MHz band. In general, since a base station supports many mobiles, base station transmissions are more frequent than mobile transmissions. Consequently, this analysis has focused on LMS base station transmissions. Since mobile transmissions are generally sporadic and (obviously) mobile, the interference potential may be higher due to proximity but much lower due to short duration. For the interference cases examined above, interfering signal power from a passing mobile is entirely consistent with the type of short duration interference Part 15 devices are designed to handle from other Part 15 devices. A comparison of LMS mobile devices with other Part 15 devices is beyond the scope of this paper.

XIII. Summary of Interference Analysis

The following table summarizes the various urban and suburban interference scenarios analyzed in this paper.

<table>
<tr><th colspan="3">LMS Compatibility Study</th></tr>
<tr><td colspan="3">Urban Scenarios
LMS Antenna Height = 200 Feet (Rooftop)
Height of Neighboring Buildings = 180 Feet
Road width = 50 Feet
Distance Between Buildings = 100 Feet</td></tr>
<tr><td colspan="3">WLAN</td></tr>
<tr><td rowspan="2">WLAN Element Receiving Interference</td><td colspan="2">Interfering Signal Strength</td></tr>
<tr><td>Part 15 Device
1 floor directly below
1SM Propagation
Tx power 12 dB below max allowed</td><td>LMS Antenna
Adjacent Rooftop
COST-WI LOS Propagation</td></tr>
<tr><td>WLAN Access Point
20 feet from building exterior
100 feet above ground level</td><td>-21.2 dBm</td><td>-49.8 dBm</td></tr>
<tr><td>WLAN Workstation
10 feet from building exterior
100 feet above ground level</td><td>-31.0 dBm</td><td>-55.6 dBm</td></tr>
<tr><td>WLAN Workstation
30 feet from building exterior
100 feet above ground level</td><td>-31.0 dBm</td><td>-51.7 dBm</td></tr>
<tr><td colspan="3">Ricochet</td></tr>
</table>

Pole Tope Receiver Receiving Interference	Interfering Signal Strength	
	Part 15 Device *500 feet away (line of sight)* *35 feet above ground level* *COST-WI LOS Propagation* *Tx power 12 dB below max allowed*	LMS Antenna *500 feet away (non-line-of-sight)* *Rooftop Mounted* *COST-WI NLOS Propagation*
Pole Top Receiver *15 feet above ground level*	-59.6 dBm	-71.6 dBm
Suburban Scenarios *LMS Antenna Height = 150 Feet (Monopole)* *Height of Neighboring Buildings = 35 Feet* *Road width = 60 Feet* *Distance Between Buildings = 120 Feet*		
Part 15 Devices		
Part 15 Device Receiving Interference	**Interfering Signal Strength**	
	Part 15 Device *Mounted on roof of shopping mall* *0.1 mile away (non-line-of-sight)* *50 feet above ground level* *COST-WI NLOS Propagation*	LMS Antenna *Monopole mounted* *0.5 mile away (non-line-of-sight)* *150 feet above ground level* *COST-WI NLOS Propagation*
Automatic Meter Reader *Hand held device* *6 feet above ground level*	-57.1 dBm	-58.5 dBm
Cordless Telephone *Located in private home* *15 feet above ground level*	-63.8 dBm	-65.9 dBm

Conclusion

The analyses contained in this paper illustrate that even "high-density" LMS systems do not present an interference risk to Part 15 devices significantly greater than the inherent interference risk from other Part 15 devices. The examination of comparative power levels, combined with band occupancy considerations, indicate that additional flexibility for LMS systems will not cause an unacceptable level of interference to Part 15 devices.

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Mark E. McDowell is an independent consultant. He was formerly the President of Invertix Corporation and Vice President and member of the Board of Directors of TeleCorp PCS. He holds BS and MS degrees in electrical

engineering and computer science from MIT. Contact: mark.mcdowell@comcast.net.

Appendix B

Mathematical Demonstration:
Reducing Power from 30 Watts ERP to 6.1 Watts ERP Does Not Impact
The Area of Potential Interference to Part 15 Devices

Background

It is assumed that an M-LMS network is deployed to provide coverage to a given geographic area. The area will be large enough that multiple M-LMS transmitters (TXs) are required to serve it. The allocated power level will dictate the number of TXs required to serve the area at a specified power density.

Since path loss slope over an area is constant and not related to power, reducing power merely necessitates more TXs to be deployed within the target coverage area. It has no effect on the cumulative area of potential interference. In a high-power TX, the area of potential interference extends a certain distance around the TX. The distance is related to the power level at which the affected device is caused harmful interference. It is possible to show mathematically that the potentially impacted *area* (not distance) does not change with power in a contiguous coverage multi-TX system.

Path Loss

Path loss can be characterized numerous ways. The simplest but least accurate in a multi-path environment is Free Space Loss (FSL). FSL is often the model selected by those opposing modifications to the M-LMS rules to calculate interference contours because the contours derived are significantly larger than those derived using more appropriate models like COST-Walfisch-Ikagami (COST-WI), Longley Rice, HATA, and Okumura. For purposes of this demonstration, only FSL is used.

Area of Potential Interference

The area of potential interference is the geographic area in which an interfering signal exceeds a defined threshold. For purposes of this demonstration, we use an interference threshold of -28.8 dBm, the level at which an adjacent channel might overload a low selectivity receiver.

30 Watt ERP Case

For a reference distance of 10 miles, the path loss predicted is 115.7 dB. Assuming that a field signal strength of –68.8 dBm were required for the system receiver to operate, a single 30-Watt ERP TX would be capable of delivering service to an area of more than 314 square miles (the area described by a 10 mile radius circle), based on the following formula:

TX EIRP - Path Loss = signal strength at distance

In this case the EIRP is 46.9 dBm (30 Watts ERP) – 115.7 dB of path loss = -68.8 dBm of signal at the receiver 10 miles away.

10 Watt EIRP Case

Covering this same area with a 10 Watt EIRP TX will require more TXs to be deployed. Using the formulae above, 40 dBm-115.7 dB = -75.7 dBm, or 6.9 dB under the target –68.8 dBm threshold. Since power is limited, the only way to achieve the threshold is to reduce the distance the TX covers until the path loss is only 108.8 dB. In order to achieve the same signal strength at the edge of coverage, the distance must be limited to 4.5 miles. The area covered by a 4.5-mile radius circle is 63.5 square miles. In order to serve the same 314 square mile area, 5 TXs would be required.

4 Watt EIRP Case (Part 15 Device)

The same area could be covered by devices operating under Part 15 rules. In this case the power is limited to 4 Watts EIRP, or 36 dBm. The path loss equation is identical: 36 dBm-115.7 dB = -79.7 dB. Again, power is limited so the path loss must be reduced by 10.9 dB to 104.8 dB. The distance at which this path loss is achieved is 2.9 miles. The area covered by this TX is 26.4 square miles, so 12 TXs will be necessary to cover the same area.

Identical Areas of Potential Interference for All Three Power Levels

With an interference threshold of -28.8 dBm, the distance covered by a potential interfering signal is 1/100th of the distance covered by the TX, since FSL defines loss as 20 dB per decade.

In the case of the 30 Watt ERP system, the distance covered by a potential interfering signal is therefore 0.1 mile, or 0.03 square miles, or 0.009% of the covered area.

In the case of the 10 Watt EIRP system, each TX would produce a potential interference area of .006 square miles. Since there are 5 TXs required, the cumulative area would be .006*5, or 0.03 square miles. Again, this calculates to 0.009% of the covered area.

Finally, in the case of the Part 15 device, the device would produce a potential interference area of 0.0026 square miles. Twelve TXs will produce a cumulative area of 0.03 square miles or 0.009% of the covered area.

Conclusion

It has been mathematically demonstrated that reducing power *cannot* yield an improvement in the area potentially impacted by interference from LMS operations. Reducing power has no effect on interference, but a marked effect on system financial viability. The *de minimis* area of potential interference is reduced further by the use of gain antennas, which maximize range and minimize near-site power levels.